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BERGER ASSOCIATES INC HARRISBURG PA
NATIONAL DAM INSPECTION PROGRAM. GREENWOOD DAM (NDS-PA-00701; D--ETC(U)
FEB 79 DACW31-79-C-0012

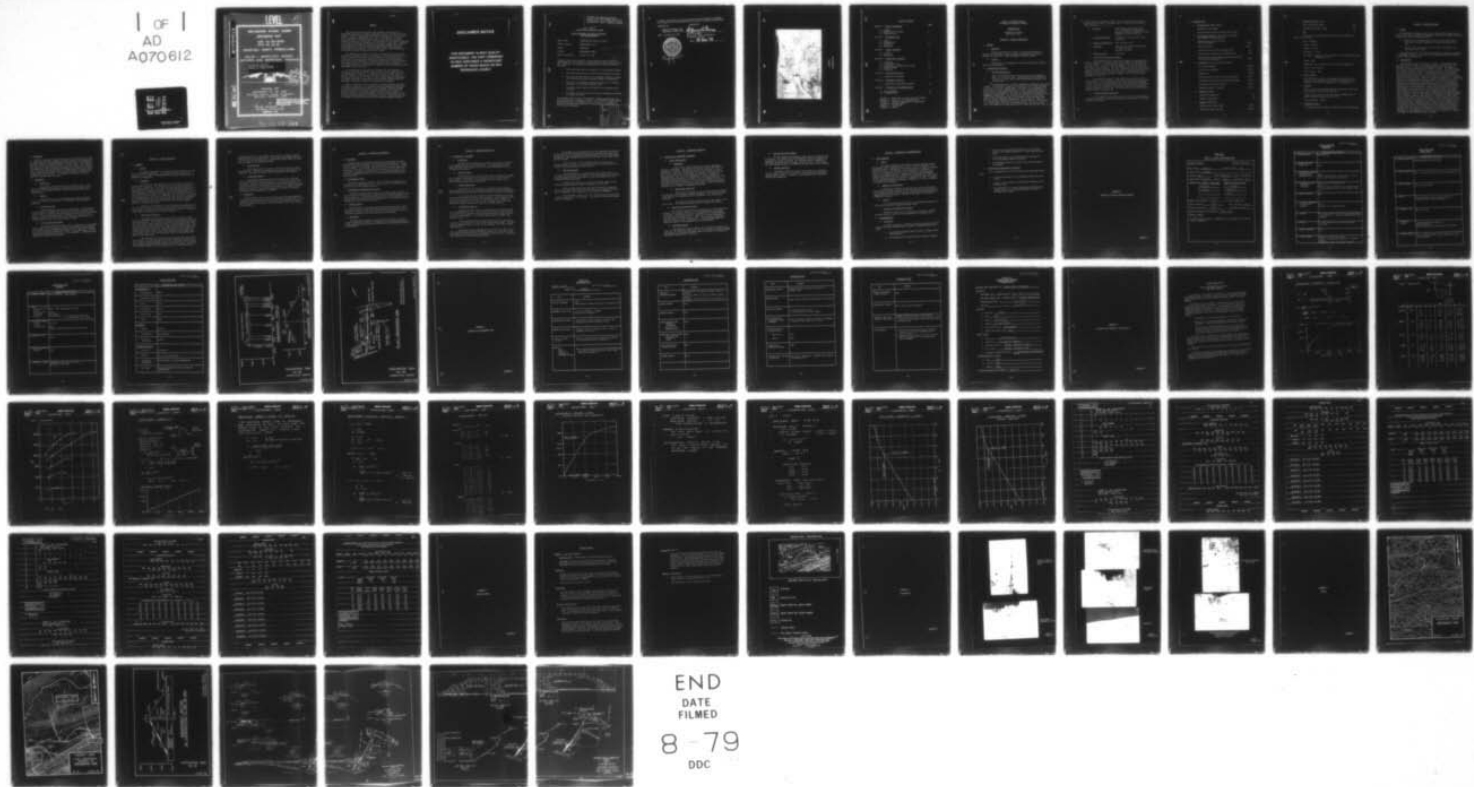
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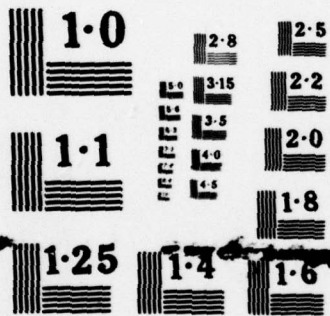
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NATIONAL BUREAU OF STANDARDS
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LEVEL

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DELAWARE RIVER BASIN

GREENWOOD DAM

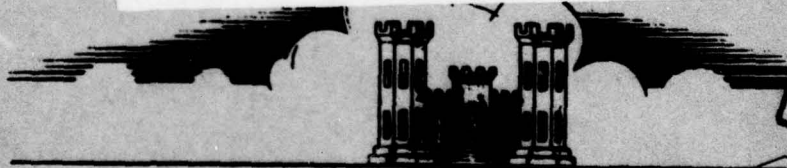
NDS No. PA-00701

DER No. 54-31

SCHUYLKILL COUNTY, PENNSYLVANIA

**PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM**

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PREPARED FOR
DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

BY

Berger Associates, Inc.
Harrisburg, Pennsylvania

FEBRUARY 1979

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PREFACE

This report has been prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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A formal surveillance and downstream warning system should be developed by the owner to be used during periods of high or prolonged precipitation.

SUBMITTED BY:

BERGER ASSOCIATES, INC.
HARRISBURG, PENNSYLVANIA

DATE: February 20, 1979



APPROVED BY:

G. K. Withers
G. K. WITHERS
Colonel, Corps of Engineers
District Engineer

DATE 18 Mar 79



OVERVIEW
GREENWOOD DAM

TABLE OF CONTENTS

	<u>Page</u>
SECTION 1 - <u>PROJECT INFORMATION</u>	
1.1 GENERAL	1
1.2 DESCRIPTION OF PROJECT	1
1.3 PERTINENT DATA	3
SECTION 2 - <u>ENGINEERING DATA</u>	
2.1 DESIGN	5
2.2 CONSTRUCTION	5
2.3 OPERATION	6
2.4 EVALUATION	6
SECTION 3 - <u>VISUAL INSPECTION</u>	
3.1 FINDINGS	7
3.2 EVALUATION	8
SECTION 4 - <u>OPERATIONAL PROCEDURES</u>	
4.1 PROCEDURES	9
4.2 MAINTENANCE OF DAM	9
4.3 MAINTENANCE OF OPERATING FACILITIES	9
4.4 WARNING SYSTEM	9
4.5 EVALUATION	9
SECTION 5 - <u>HYDROLOGY/HYDRAULICS</u>	
5.1 EVALUATION OF FEATURES	10
SECTION 6 - <u>STRUCTURAL STABILITY</u>	
6.1 EVALUATION OF STRUCTURAL STABILITY	12
SECTION 7 - <u>ASSESSMENT AND RECOMMENDATIONS</u>	
7.1 DAM ASSESSMENT	14
7.2 RECOMMENDATIONS	14
APPENDIX A - CHECK LIST OF VISUAL INSPECTION REPORT	
APPENDIX B - CHECK LIST OF ENGINEERING DATA	
APPENDIX C - HYDROLOGY AND HYDRAULIC CALCULATIONS	
APPENDIX D - GEOLOGIC REPORT	
APPENDIX E - PHOTOGRAPHS	
APPENDIX F - PLATES	

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

GREENWOOD DAM

NDS-ID NO. PA-00701
DER-ID NO. 54-31

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

A. Authority

The Dam Inspection Act, Public Law 92-367 authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspections of dams throughout the United States.

B. Purpose

The purpose is to determine if the dam constitutes a hazard to human life and property.

1.2 DESCRIPTION OF PROJECT

A. Dam and Appurtenances

Abstract →
Note: The spillway weir in this report is set at elevation 1059.0 as per U.S.G.S. map. Drawings dated 1935 indicate an elevation of 1057.0 and an older drawing shows elevation 1055 at pool level.

Greenwood Dam is an earthfill embankment, originally constructed in 1880. The embankment height was increased in 1901 or 1904 and again in 1935 to its present configuration. The length of the embankment is about 850 feet with a maximum height of 32 feet. Four 20-inch pipes are placed under the embankment with valves at the downstream end without control at the upstream end. The pipes are supported on a masonry wall (Appendix F, Plate III). The outlets of these pipes are not visible because they are submerged under the backwater of the Lake Hauto Dam, which is located immediately downstream. The spillway is located in the left abutment, about 100 feet from the end of the dam. The spillway is a concrete ogee weir and the discharge channel is cut out of the rock. The length of the ogee section is 94.5 feet and the weir crest is

→ 2.0 feet above the approach channel. The left side of the spillway is sloped and cement paved. The right side is a vertical wall of stone, laid in mortar. ← ABSTRACT

- B. Location: Rush Township, Schuylkill County
U.S.G.S. Quadrangle, Tamaqua, PA
Latitude 40°-49.9', Longitude 75°-56.4'
(Appendix F, Plates I and II)
- C. Size Classification: Intermediate (32 feet high, 2,160 acre-feet)
- D. Hazard Classification: High (Section 3.1.E)
- E. Ownership: Dual Valley Recreation Association
45 Center Street
Lansford, PA 18232
- F. Purpose of Dam: Recreation
- G. Design and Construction History

The Greenwood Dam was built by the Lehigh Coal and Navigation Company in 1880 for the Panther Valley Water Company, a subsidiary of the coal company. It was constructed under a force account under the direction of the engineer of the coal company. In 1901, the capacity of the reservoir was increased. The above information was obtained from a report by PennDER, dated April 19, 1915, which states that to the writers knowledge no core or cutoff walls were used. A drawing dated 1901, obtained from the owner, indicates a puddle clay core in the section. (Appendix F, Plate III).

The dam had a length of about 2300 feet in 1901, of which nearly 1900 feet was paralleling a low-lying railroad on the south side of the reservoir. This railroad was relocated to higher ground prior to 1935. When the embankment height was increased in 1935, a new dike of about 300 feet in length was constructed, rather than raising the long western end of the old dam. The 1935 alterations were designed by Gannett, Eastman & Fleming, Inc.

H. Normal Operating Procedures

The reservoir created by the dam is used for recreation only. All inflow is either stored below spillway weir elevation or discharged through the spillway.

1.3 PERTINENT DATA

A. <u>Drainage Area</u> (square miles)		
Computed for this Report		5.6
Design engineer used 6.0 square miles in 1935.		
B. <u>Discharge at Dam Site</u> (cubic feet per second)		
See Appendix C for calculations		
Maximum known flood at dam site		
June, 1972 (Agnes)	1,960	
Warm water outlet	None	
Outlet pipes at low pool elevation 1039	40	
Outlet pipes at normal pool elevation 1059	100	
Spillway capacity at maximum pool elevation 1066.1 (low point of embankment)	4,380	
C. <u>Elevation</u> (feet above mean sea level)		
Top of dam (design)	1,066.5	
Low point in embankment	1,066.1	
Normal pool	1,059.0	
Upstream portal invert of outlet pipes about	1,032	
Downstream portal invert of outlet pipes about	1,031.5	
Streambed at centerline of dam	1,034	
Maximum tailwater - Estimate	1,040	
D. <u>Reservoir</u> (miles)		
Length of maximum pool	1.1	
Length of normal pool	.95	
E. <u>Storage</u> (acre-feet)		
Spillway crest (Elev. 1059)	1,130	
Top of dam (Elev. 1066.10)	2,160	

F. Reservoir Surface (acres)

Top of dam (Elev. 1066.5) 175

Spillway crest (Elev. 1059) 110

G. Dam

For general plan and typical sections refer to Appendix F, Plates III, IV and V.

Type: Earthfill.

Length: 850 feet.

Height: 32 feet.

Top Width: 12 feet.

Side Slope: Upstream 1.5H to 1V and 2.5 feet high concrete wall.
Downstream 2H to 1V.

Zoning: None.

Impervious Core: Probably a 3-foot wide clay puddle core.

Cutoff: None reported.

Grout Curtain: None.

H. Outlet Conduit

Four 20-inch pipes under the embankment (two rows of two) supported on a continuous masonry wall (10 feet deep). Two vertical valves and two sloped valves at downstream end.

I. Spillway

Type: Uncontrolled standard ogee weir with chute cut in rock and sloped at .5 percent over 500 feet.

Length: 94.5 feet at crest with vertical abutment wall at right and paved sloping section at left.

Crest elevation: 1059.0.

J. Regulating Outlet

Two vertical valves operable at present time on 20-inch pipes.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

The available engineering data did not contain actual design information. This report is based on information included on drawings reproduced in Appendix F and the following reports.

- a. Report on the "Greenwood Dam" based on a field inspection by P.W. Pierce, Assistant Engineer of PennDER, dated April 19, 1915.
- b. Report on the "Application" for increasing the height of the dam, dated July 3, 1935.

The design data did not include calculations for hydrology, hydraulics or embankment stability. The check list of engineering data is included in this report as Appendix B.

2.2 CONSTRUCTION

The dam was originally constructed in 1880. A major modification was made in 1901 or 1904. The dam was raised to elevation 1062. The present owners of the dam had two drawings available. One drawing indicates a proposed scheme, dated November 13, 1900. The other drawing had a typical section redrawn on Plate III, Appendix F and is indicated as "original dam 1901 or 1904". A photograph made in 1915 indicates that the end of the pipes were concrete encased. During heavy rains in August and September 1933, water rose to 2-feet from the top of the dam (3-feet over the spillway). Gannett, Eastman and Fleming, Inc., consulting engineers, recommended increasing the height of the dam at least two feet, without alterations to the spillway. Plans were drawn (Plate IV, Appendix F) and construction started in August, 1935. The embankment was raised 2.5 feet by installing a five feet high concrete wall at the upstream edge of the embankment. Construction specifications indicate that topsoil was removed and the new fill behind the wall was rolled. The railroad on the south side of the reservoir had been relocated to higher ground in previous years and the embankment was extended southward with a new dike. The old south breast of the dam was partially breached with a concrete channel at elevation 1057. Stoplogs, in this breach channel, were used to prevent flooding of the area between the relocated railroad and the old south breast. Refer to Plate IV, Appendix F, for plans and sections. Drainage of this isolated area was provided for by a 12-inch pipe with a downstream control valve. During construction it was decided to remove loose material in the spillway and to install a concrete ogee weir along the extension of the centerline dam (Plate V, Appendix F). The approach was cleaned out to 2-feet below weir crest elevation and the spillway chute was excavated to a grade of .5 percent. No changes to the downstream slope were made.

2.3 OPERATION

There are no formal records available for the operation of the dam. The dam was constructed to augment the water supply of the downstream dam (Lake Hauto) by releases through the 20-inch pipes. At present the reservoir is used for recreation only. Reports indicate that leakage near the blowoff pipes has existed since at least 1915. At the request of PennDER, weirs were installed and readings were submitted to Harrisburg. Quantities varied from 2,000 to 70,000 gallons per day per weir, without a correlation between pool level and quantity. Readings were discontinued in January 1917. The leakage was reported in several reports as constant and not serious.

2.4 EVALUATION

A. Availability

The available engineering data for evaluation were in the files of PennDER and two drawings in possession of the owner. It was limited to a few drawings, reports, inspection reports and general correspondence.

B. Adequacy

The available data was not adequate for making a detailed analysis or review of the design of the embankment and appurtenant structures.

C. Operating Records

Formal operating records are not maintained. Correspondence indicates that the maximum flow over the old spillway was about 3 feet in 1933 before the spillway was improved with an ogee section and sloping chute. In 1936 the maximum flow was recorded as .25 feet over the spillway with all four valves open, and an estimated discharge of 320 million gallons per day (495 cfs) through the pipes.

D. Post Construction Changes

Two major changes were made after the completion of the original dam in 1880. The first change involved increasing the storage capacity of the reservoir by increasing the height and the length of the embankment and was probably accomplished in 1901. The second change, in 1935, also involved increasing the height of the embankment. The spillway was improved to increase its efficiency.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

A. General

The general appearance of Greenwood Dam and facilities is fair due to the lack of maintenance. The visual inspection report is in Appendix A of this report. Photographs taken during the inspection are reproduced in Appendix E.

B. Embankment

At the time of inspection, the pool level was just above the spillway weir elevation. The embankment was raised using a concrete wall at the upstream side. This wall has some deterioration but this is not considered critical at this time. The upstream slope consists of riprap and has a considerable amount of weeds and brush growth. The top of the embankment is irregular in width and is covered with grass and some weeds. The elevation of the embankment crest is uneven. The center of the embankment is lower than the two ends (See Plate A-1, Appendix A). The downstream slope has loose riprap and a heavy growth of weeds and brush. No seepage on the slope was detected, but the heavy growth prevented a thorough inspection.

Lake Hauto (NDI No.606) is located immediately downstream from this dam and this causes some marshy areas below the toe of the dam. A small amount of seepage near the right abutment was noticed. The amount being small, does not appear to present a problem.

C. Appurtenant Structures

Four 20-inch pipes supported on a masonry wall are located under the embankment with underwater intakes and controlled by valves at the downstream end. These valves are exposed to the weather and accessible with a small wooden platform erected over the upstream end of Lake Hauto Reservoir. This platform is in poor condition and not safe. The valves are arranged with two vertical valve systems in the center and a sloping valve stem at each side. Representatives of the Association stated that the two vertical valves were opened two years ago to lower the reservoir level. The two slope valves have not been operated for many (at least 20) years.

The spillway is located in the left abutment and is cut into the hillside. The concrete weir has a small downstream concrete apron and a vertical concrete abutment wall on the right side. The left side has a sloping concrete abutment, poured on the rock surface. The spillway discharge channel is cut into the rock but is totally grown full

with brush and trees. This channel could easily be plugged by debris during periods of high discharges. The maximum reported discharge was 3.5 feet over the weir during the tropical storm Agnes (1972), at which time no damage to the spillway occurred.

D. Reservoir Area

The reservoir area is used for recreation (boating, fishing and swimming). The banks are wooded except a small sandy beach at the clubhouse. The banks are stable and no sedimentation is reported.

E. Downstream Channel

The heavily overgrown spillway discharges into a man-made stream channel outlet which discharges, in a very short distance, into Lake Hauto. Failure of Greenwood Dam due to overtopping would cause overtopping failure of the downstream Lake Hauto Dam. Additional hazard to loss of life due to these successive failures is expected in Hauto Estates, an industrial park and Nesquehoning; therefore, the Hazard Classification is considered to be "High".

3.2 EVALUATION

Weed and brush control on the upstream and downstream embankment slopes has been minimal and should be performed on an annual basis. The overgrown discharge channel of the spillway needs immediate attention and the platform at the valves should be maintained in a safe condition for emergencies.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURE

Greenwood Dam was originally constructed to supplement the water supply of Lake Hauto Reservoir, located immediately downstream. During the last twenty years, however, the reservoir has been used as a recreational facility. It was first taken over by a real estate company and at present it belongs to the Dual Valley Recreation Association. The pool level is maintained at spillway weir crest elevation and is only lowered, by opening the valves, if this is required for maintenance of docks and beach.

4.2 MAINTENANCE OF DAM

The visual inspection indicates that very little maintenance is performed on the embankment slopes. Some cutting has occurred because no trees were on the downstream slope.

4.3 MAINTENANCE OF OPERATING FACILITIES

A schedule of operating the valves on a regular basis does not exist. The two vertical valves appear operable and should be sufficient for emergency use. The platform, however, is in unsafe condition. It appears that no maintenance has been performed on the spillway discharge channel during the last 10 to 20 years.

4.4 WARNING SYSTEM

Representatives of the Recreation Association stated that a phone alarm system has been organized downstream to be used in case of an emergency. However, there is no formal surveillance system to be activated during periods of prolonged and heavy precipitation.

4.5 EVALUATION

The operational procedures at this dam are poor due to lack of a regular maintenance schedule for embankment and operating facilities. A formal surveillance and downstream warning system is lacking and should be implemented.

SECTION 5 - HYDROLOGY/HYDRAULICS

5.1 EVALUATION OF FEATURES

A. Design Data

The hydrologic and hydraulic analyses available from PennDER for Greenwood Dam were not very extensive. No stage-storage curve, stage discharge curve, design storm data, flood hydrographs or flood routings were available.

B. Experience Data

In the period since 1935, when the breast elevation of the dam was increased, the maximum flood occurred in 1972. At that time the pool reached a level about 3.5 feet higher than the spillway crest. This flood was passed without difficulty.

C. Visual Observations

On the date of the inspection, no conditions were observed that would indicate that the appurtenant structures of the dam could not operate satisfactorily during a flood event until the dam is overtopped.

It was noted that the spillway channel downstream of the ogee section was overgrown with small trees and brush. This condition, which had also been noted in several prior inspection reports, causes an increase in tailwater at the ogee section. Removal of the trees and brush would greatly increase the spillway discharge capacity.

D. Overtopping Potential

Greenwood Dam has a total storage capacity of 2,160 acre-feet, at the embankment low point elevation of 1066.1, and an overall height of 32 feet above streambed. These dimensions indicate a size classification of "Intermediate". The hazard classification is "High" (See Section 3.1.E).

The recommended Spillway Design Flood (SDF) for a dam having the above classifications is the Probable Maximum Flood (PMF). For this dam, the PMF peak inflow is 7,580 cfs (see Appendix C for HEC-1 inflow computations).

Comparison of the estimated PMF peak inflow of 7,580 cfs with the estimated maximum spillway discharge capacity of 4,380 cfs, at the elevation of the low point of the embankment, indicates that a potential for overtopping of the Greenwood Dam exists.

An estimate of the storage effect of the reservoir and routing of the computed inflow hydrograph through the reservoir shows that this dam does not have the necessary storage available to pass the PMF without overtopping. The spillway-reservoir system can pass a flood event equal to 73% of a PMF.

If the low area in the embankment would be raised to the design elevation of 1066.5, the spillway-reservoir system would be able to pass a flood event equal to 78% of a PMF.

E. Spillway Adequacy

The intermediate size category and high hazard category, in accordance with the Corps of Engineers criteria and guidelines, indicates that the Spillway Design Flood (SDF) for this dam should be the full Probable Maximum Flood (PMF).

Calculations show that the spillway discharge capacity and reservoir storage capacity combine to handle 73% of the PMF.

Since the dam cannot pass the full PMF without overtopping, but can pass more than one-half the PMF without overtopping, the spillway is considered to be inadequate but not seriously inadequate.

The hydrologic analysis for this investigation was based upon existing conditions of the watershed. The effects of future development were not considered.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

A. Visual Observations

1. Embankment

There were no visual indications of undue embankment stresses or sloughage. The downstream slope is steep (1.5H to 1V) but appeared to be stable. Although the heavy brush prevented a close inspection, a small area with seepage was noticed. The toe is marshy over a large area due to the backwater of Lake Hauto, formed by a downstream dam. The top of the embankment is uneven in width but is considered sufficient with the concrete wall on the upstream side. The upstream slope was measured as 2.2H to 1V, but is probably 2H to 1V. The riprap protection is adequate, if brush growth would be controlled. The top of the dam profile is uneven and is about .4 feet below design elevation over a length of approximately 400 feet.

2. Appurtenant Structures

The two vertical valves on the 20-inch pipes are operable and sufficient for emergency drawdown procedures. The operator's platform, however, is deteriorated and is considered to be in an unsafe condition.

The spillway weir was in good condition and appears to be set in rock. The spillway abutment walls are adequate and stable.

B. Design and Construction Data

The available design and construction data are not adequate to evaluate the structural stability of the embankment and appurtenant structures. The downstream slope is considered to be steep compared with present engineering practice. However, no serious problems have occurred since its construction in 1901. The banks of the spillway chute are stable and any erosion due to a large discharge would not effect the safety of the embankment due to its location.

C. Operating Records

The inspection reports indicate that seepage has existed for a long time. The inspection team found only one location with minor seepage. The presence of Lake Hauto backwater makes it difficult to determine if additional seepage exists at the toe.

D. Post Construction Changes

The dam height was increased in 1935 under the supervision of an engineer. The concrete wall and embankment backing is adequate and increased the safety of the dam. The spillway channel improvements, consisting of excavating the forebay, construction of a concrete ogee weir and sloping the chute, all improved the efficiency of the spillway.

E. Seismic Stability

This dam is located in Seismic Zone 1 and it is considered that the static stability is sufficient to withstand minor earthquake induced dynamic forces. No studies or calculations have been made to confirm this assumption.

SECTION 7 - ASSESSMENT & RECOMMENDATIONS

7.1 DAM ASSESSMENT

A. Safety

The visual inspection, the review of design drawings and the operational history indicates that the dam is in fair condition. The downstream slope is considered to be steep; however, no signs of distress have been noticed. The seepage is not considered to be serious at present. In accordance with the Corps of Engineers evaluation guidelines, the spillway capacity is inadequate for passing the Probable Maximum Flood (PMF) peak inflow without overtopping the dam. The combination of storage and spillway capacity is sufficient to pass 73 percent of the PMF and although the spillway is inadequate, it is not considered to be seriously inadequate.

B. Adequacy of Information

Although the available engineering data is not sufficient to make detailed stability analyses of the dam and appurtenant structures, the available drawings, reports and the observed physical conditions are judged sufficient for making a reasonable assessment of the overall condition of the dam.

C. Urgency

It is considered important that the recommended suggestions in this section should be implemented without delay.

D. Necessity For Additional Studies

Additional studies are not required at this time. However, attention should be given to the recommendations presented below.

7.2 RECOMMENDATIONS

A. Facilities

In order to assure a continued satisfactory operation of this dam the following recommendations are made for implementation by the owner:

1. The spillway discharge channel should be cleared of all brush and trees.
2. The platform at the blowoff valves should be repaired.

3. The top of the dam should be brought up to an uniform height at the design elevation of 7.5 feet above spillway crest.
4. A positive cutoff at the upstream end of the pipes for use in emergencies should be provided.
5. The embankment should be cleared of all brush and heavy weed growth.

B. Operation and Maintenance Procedures

It is recommended that the owner initiate the following procedures:

1. A regular maintenance of the embankment slopes and crest of dam.
2. A twice a year schedule of greasing and operation of the drawdown valves.
3. The development of a formal surveillance and downstream warning system to be used during periods of high or prolonged precipitation.

APPENDIX A

CHECKLIST OF VISUAL INSPECTION REPORT

APPENDIX A

CHECK LIST

PHASE I - VISUAL INSPECTION REPORT

PA DER # 54-31-T1

NDI NO. PA-00 701

NAME OF DAM Greenwood HAZARD CATEGORY High

TYPE OF DAM Earthfill

LOCATION Rush TOWNSHIP Schuylkill COUNTY, PENNSYLVANIA

INSPECTION DATE 10/25/78 WEATHER Sunny TEMPERATURE 60's

INSPECTORS: H. Jongsma (Recorder)

OWNER'S REPRESENTATIVE(s):

A. Bartlett

W. T. Richards

R. Shireman

F. Griffiths

T. Yost

NORMAL POOL ELEVATION: 1059.0

AT TIME OF INSPECTION:

BREAST ELEVATION: 1066.5

POOL ELEVATION: 1059.0

SPILLWAY ELEVATION: 1059.0

TAILWATER ELEVATION:

MAXIMUM RECORDED POOL ELEVATION: 1062.5 (1972)

GENERAL COMMENTS:

An alarm system by phone is supposedly to be organized to be used in times of emergency.

VISUAL INSPECTION
EMBANKMENT

	OBSERVATIONS AND REMARKS
A. SURFACE CRACKS	None detected.
B. UNUSUAL MOVEMENT BEYOND TOE	None.
C. SLOUGHING OR EROSION OF EMBANKMENT OR ABUTMENT SLOPES	None. Some deterioration of concrete wall on top of wall. Not critical at this time.
D. ALIGNMENT OF CREST: HORIZONTAL: VERTICAL:	Concrete wall at upstream side. Good. Concrete wall alignment good. Irregular height of fill behind the wall. Mostly higher than wall.
E. RIPRAP FAILURES	None.
F. JUNCTION EMBANKMENT & ABUTMENT OR SPILLWAY	Good. Spillway cut in natural ground.
G. SEEPAGE	Lake Hauto directly below stream causing marshy areas below toe. Some minor seepage near right abutment.
H. DRAINS	In south extension to drain low area near railroad.
J. GAGES & RECORDER	None.
K. COVER (GROWTH)	Upstream - riprap with weeds. Breast - concrete wall and grass - irregular width. Downstream riprap, heavy weeds & brush.

VISUAL INSPECTION
OUTLET WORKS

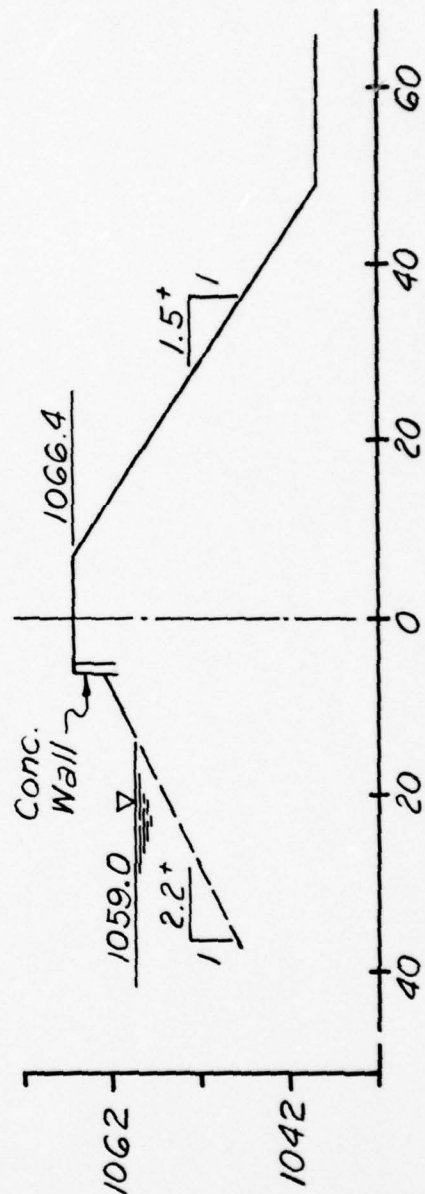
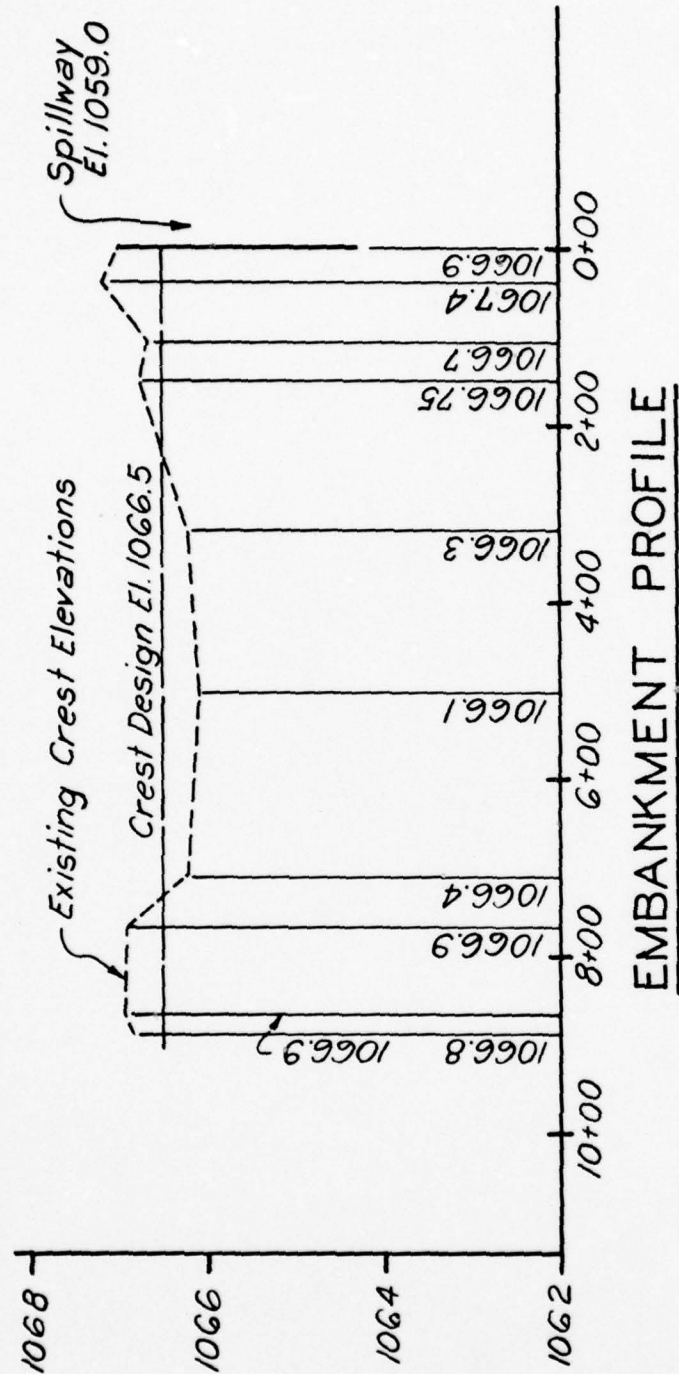
	OBSERVATIONS AND REMARKS
A. INTAKE STRUCTURE	Submerged pipes with open ends.
B. OUTLET STRUCTURE	None - 4 pipes with valve control at downstream toe.
C. OUTLET CHANNEL	Pond, clear entrance.
D. GATES	Two slope valves and two vertical valves at downstream end. All 20 inch pipes.
E. EMERGENCY GATE	None (2 valves).
F. OPERATION & CONTROL	Last time opened two years ago. Unsafe platform. Slope valves have not been used for many years.
G. BRIDGE (ACCESS)	None. Wooden platform in poor condition at downstream valves.

VISUAL INSPECTION
SPILLWAY

	OBSERVATIONS AND REMARKS
A. APPROACH CHANNEL	Cut in hillside. Clear opening.
B. WEIR: Crest Condition Cracks Deterioration Foundation Abutments	Good - some spalling and cracking. Normal. Not visible. Concrete walls - 7.9' vertical on right side 5.0' high sloped on left side.
C. DISCHARGE CHANNEL: Lining Cracks Stilling Basin	Rock cut. None. Channel heavily grown with brush and trees.
D. BRIDGE & PIERS	None.
E. GATES & OPERATION EQUIPMENT	None.
F. CONTROL & HISTORY	Maximum 3.5 feet over weir (1972). No damage to spillway.

VISUAL INSPECTION

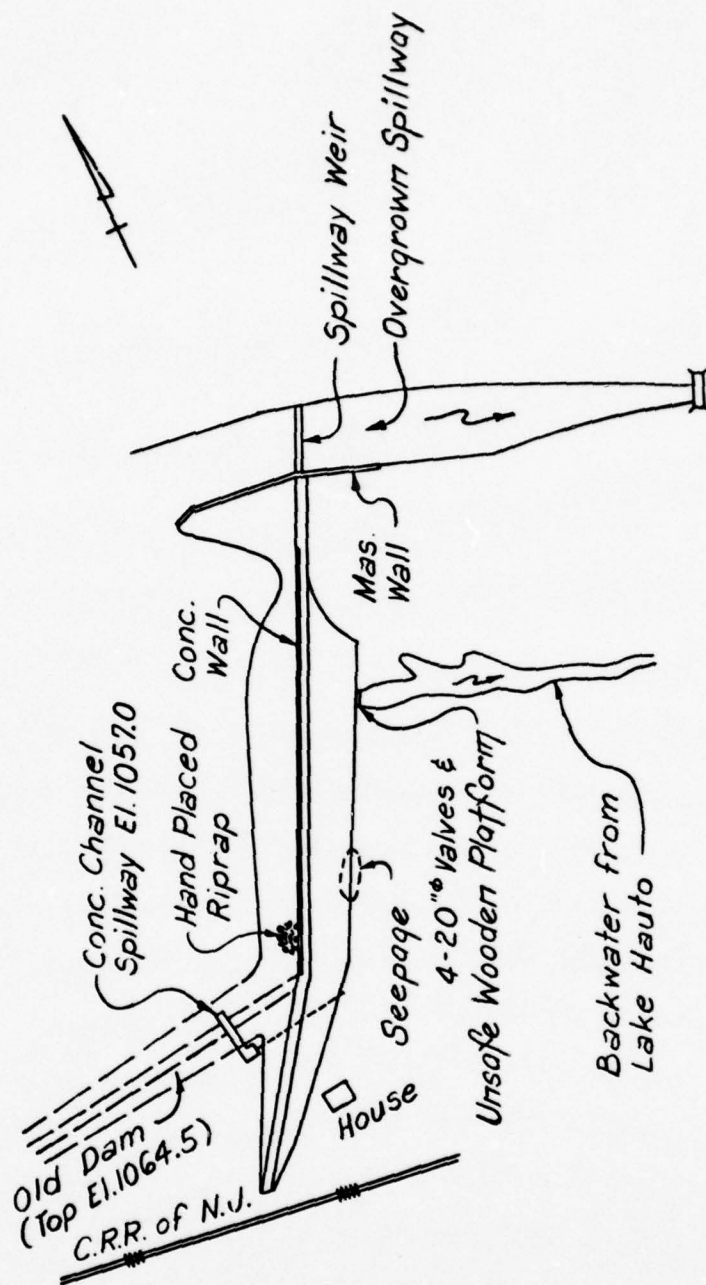
	OBSERVATIONS AND REMARKS
<u>INSTRUMENTATION</u>	
Monumentation	None.
Observation Wells	None.
Weirs	None.
Piezometers	None.
Staff Gauge	None.
Other	None.
<u>RESERVOIR</u>	
Slopes	Wooded.
Sedimentation	None reported.
Watershed Description	Wooded.
<u>DOWNSTREAM CHANNEL</u>	
Condition	Lake Hauto.
Slopes	Flat area till next dam.
Approximate Population	Hauto Estates: 30 plus Nesquehoning.
No. Homes	Couple dozen homes in Hauto Estates and Nesquehoning.



GREENWOOD DAM
PA. 701
INSPECTION SURVEY

PLATE A-I

Surveyed 10/25/78



PLAN - GREENWOOD DAM

NOTE: Normal Pool Elev.
assumed at 1059 (U.S.G.S.)

GREENWOOD DAM
PA. 701
INSPECTION SURVEY

PLATE A-II

Surveyed 10/25/78

APPENDIX B

CHECKLIST OF ENGINEERING DATA

APPENDIX B

CHECK LIST
ENGINEERING DATA

PA DER # 54-31

NDI NO. PA-00 701

NAME OF DAM GREENWOOD

ITEM	REMARKS
AS-BUILT DRAWINGS	None. Construction drawings available for raising of dam.
REGIONAL VICINITY MAP	U.S.G.S. Quadrangle - Tamaqua See Plate II, Appendix F
CONSTRUCTION HISTORY	Constructed in 1880, raised in 1901 and 1935. Concrete ogee weir installed in 1935.
GENERAL PLAN OF DAM	Schematic plan for raising in 1935. Refer to Appendix F, Plate IV.
TYPICAL SECTIONS OF DAM	Only for raising of dam in 1935 and a sketch of 1901 section (Plate III, Appendix F).
OUTLETS: PLAN DETAILS CONSTRAINTS DISCHARGE RATINGS	None, except photograph dated 4/14/1915 indicating four valves at downstream end. End of pipes encased in concrete.

ENGINEERING DATA

ITEM	REMARKS
RAINFALL & RESERVOIR RECORDS	8/23-24, 1933: 5.5 inch in 24 hours, total 8 inches. 9/2 & 9/4, 1933: 5.5 inch in 24 hours, total 6 inches. Pool level 3 feet above weir (2 feet below top of dam)
DESIGN REPORTS	None.
GEOLOGY REPORTS	None.
DESIGN COMPUTATIONS: HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None.
MATERIALS INVESTIGATIONS: BORING RECORDS LABORATORY FIELD	None.
POST CONSTRUCTION SURVEYS OF DAM	None.
BORROW SOURCES	None.

ENGINEERING DATA

ITEM	REMARKS
MONITORING SYSTEMS	Leakage measured at 3 weirs from 1915 to January 1917.
MODIFICATIONS	None, except raising and installing of ogee weir.
HIGH POOL RECORDS	3 feet above weir in 1933. 3.5 feet above weir in 1972 (Agnes).
POST CONSTRUCTION ENGINEERING STUDIES & REPORTS	Report by Gannett, Seelye & Fleming to recommend raising of dam, dated July 1, 1935.
PRIOR ACCIDENTS OR FAILURE OF DAM Description: Reports:	None. None.
MAINTENANCE & OPERATION RECORDS	None.
SPILLWAY PLAN, SECTIONS AND DETAILS	See Plate V, Appendix F. Changed from original plan (Plate IV).

ENGINEERING DATA

ITEM	REMARKS
OPERATING EQUIPMENT, PLANS & DETAILS	None.
CONSTRUCTION RECORDS	None, except some photographs.
PREVIOUS INSPECTION REPORTS & DEFICIENCIES	PennDER Inspection Reports since 8/29/18. Leakage near blowoff pipes. Brush and tree growth on slope and in spillway channel has been a pro- blem since 1922.
MISCELLANEOUS	<ol style="list-style-type: none">1. Report on the Greenwood Dam of the Panther Valley Water Company by PennDER, dated April 19, 1915.2. Photographs dated 1915, 1935, 1972 and 1974.3. Report on Application for raising dam in 1935 by PennDER.

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Mostly wooded and mountains

ELEVATION:

TOP NORMAL POOL & STORAGE CAPACITY: Elev. 1059.0 1135 Acre-Feet

TOP FLOOD CONTROL POOL & STORAGE CAPACITY: E1.1066.5 2160 Acre-Feet

MAXIMUM DESIGN POOL: Elev. 1064.5

TOP DAM: Elev. 1066.5

SPILLWAY:

- a. Elevation 1059.0
- b. Type Ogee
- c. Width 94.5 at crest.
- d. Length At least 500 feet.
- e. Location Spillover Left abutment.
- f. Number and Type of Gates None.

OUTLET WORKS:

- a. Type Four 20-inch pipes
- b. Location See Plate IV, Appendix F
- c. Entrance inverts Unknown. Estimated at 1031.5
- d. Exit inverts Unknown - Estimated at 1032.
- e. Emergency drawdown facilities 2 - 20-inch pipes with downstream valves.

HYDROMETEOROLOGICAL GAGES:

- a. Type None.
- b. Location None.
- c. Records None.

MAXIMUM NON-DAMAGING DISCHARGE: 5,000 cfs.

APPENDIX C

HYDROLOGY AND HYDRAULIC CALCULATIONS

APPENDIX C

SUMMARY DESCRIPTION
OF
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION

The hydrologic and hydraulic evaluation for this inspection report has employed computer techniques using the Corps of Engineers computer program identified as the Flood Hydrograph Package (HEC-1) Dam Safety Version.

The program has been designed to enable the user to perform two basic types of hydrologic analyses: (1) the evaluation of the overtopping potential of the dam, and (2) the capability to estimate the downstream hydrologic-hydraulic consequences resulting from assumed structural failures of the dam. A brief summary of the computation procedures typically used in the dam overtopping analysis is shown below.

- Development of an inflow hydrograph to the reservoir.
- Routing of the inflow hydrograph(s) through the reservoir to determine if the event(s) analyzed would overtop the dam.
- Routing of the outflow hydrograph(s) of the reservoir to desired downstream locations. The results provide the peak discharge, time of the peak discharge and maximum stage of each routed hydrograph at the outlet of the reach.

The output data provided by this program permits the comparison of downstream conditions just prior to a breach failure with that after a breach failure and the determination as to whether or not there is a significant increase in the hazard to loss of life as a result of such a failure.

The results of the studies conducted for this report are presented in Section 5.

For detailed information regarding this program refer to the Users Manual for the Flood Hydrograph Package (HEC-1) Dam Safety Version prepared by the Hydrologic Engineering Center, U. S. Army Corps of Engineers, Davis, California.

BY RLS
CHKD. BY
SUBJECT

DATE 12/19/78
DATE

BERGER ASSOCIATES

SHEET NO. 1 OF
PROJECT D8490

GREENWOOD DAM

SPILLWAY CHANNEL CAPACITY

$$S = .005$$

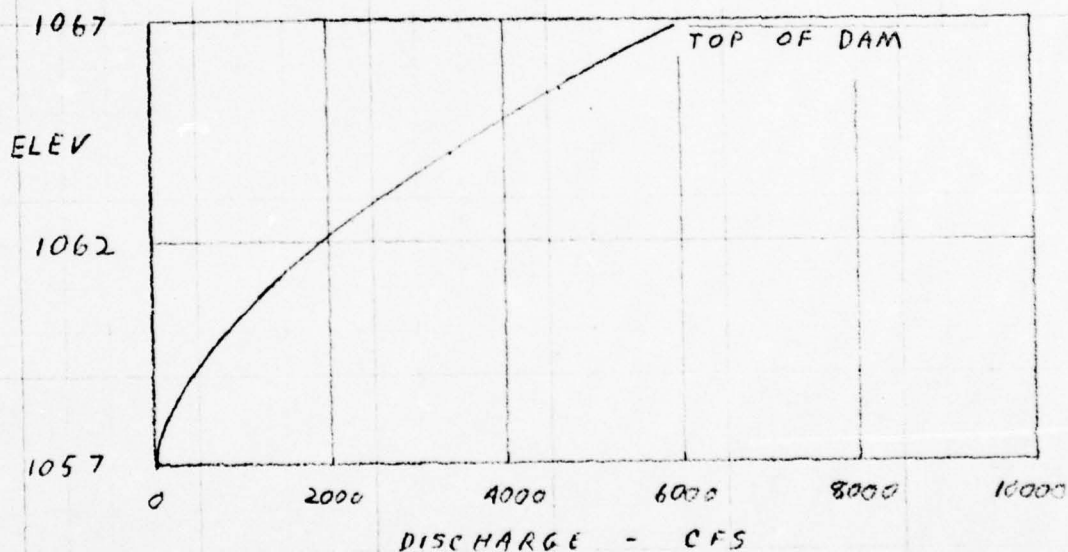
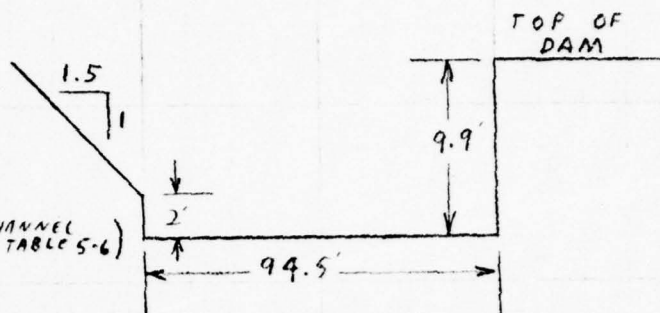
$$N = .07$$

(CHOW "OPEN CHANNEL
HYDRAULICS" TABLE 5-6)

$$Q = \frac{1.486}{N} A R^{2/3} S^{1/2}$$

$$= \frac{1.486}{.07} \times 982.3 \times 4.04 \times .0707$$

$$= 5956 \text{ CFS} \quad \text{FLOWING FULL}$$



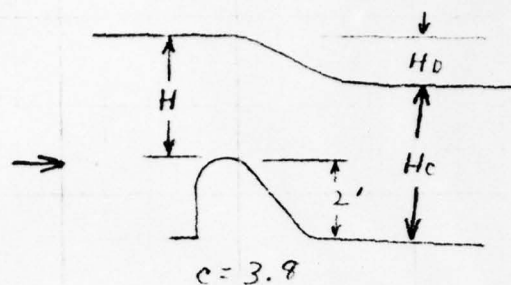
BY RLS DATE 12/14/78
 CHKD. BY _____ DATE _____
 SUBJECT _____

BERGER ASSOCIATES

SHEET NO. 2 OF
 PROJECT D8490

GREENWOOD DAM

WEIR TAILWATER



DESIGN OF
 SMALL DAMS
 FIG. 2.54

Q_A	H_c	H	H_D	H_D/H	C_w	Q
5000	8.9	7.9	1	.127	2.74	6108
		7.6	.7	.092	2.47	5185
		7.4	.5	.067	2.01	4048
4000	7.8	7.2	1.4	.194	3.23	6234
		6.8	1	.147	2.93	5175
		6.5	.7	.108	2.51	4133
		6.3	.5	.079	2.25	3530
3000	6.5	5.4	.9	.167	3.04	3759
		5.15	.65	.126	2.7	3103
		5	.5	.10	2.47	2713
2000	5.1	3.9	.8	.205	3.27	2454
		3.75	.65	.173	3.15	2226
		3.65	.55	.151	2.96	2007
1000	3.3	2.05	.75	.366	3.65	1028
		1.9	.6	.316	3.57	896
		1.8	.5	.278	3.50	810

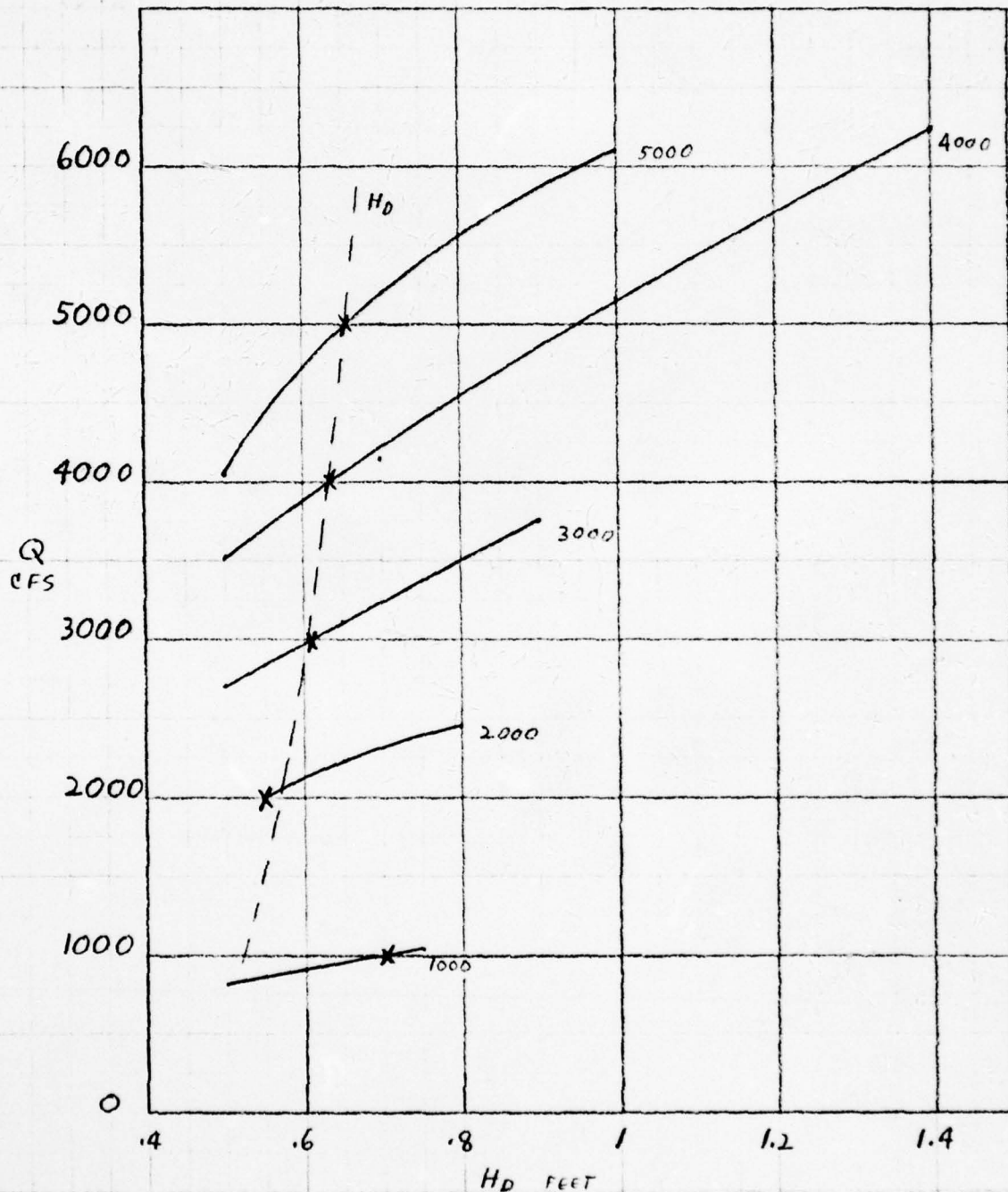
BY RLS DATE 12/14/78
CHKD. BY _____ DATE _____
SUBJECT _____

BERGER ASSOCIATES

SHEET NO. 3 OF _____
PROJECT D8990

GREENWOOD DAM

WEIR TAIL WATER



USE $H_D = 0.6'$

BY RLS DATE 12/18/78
 CHKD. BY DIR DATE 12/27/78
 SUBJECT _____

BERGER ASSOCIATES

SHEET NO. 4 OF
 PROJECT D8490

GREENWOOD DAM

SPILLWAY CAPACITY

$C = 3.8$
 (FIG. 2.49
 DESIGN OF SMALL DAMS)

WEIR IS SUBMERGED
 BY DOWN STREAM
 TAILWATER DUE TO
 OBSTRUCTED SPILLWAY
 CHANNEL.

USE $H_D = 0.6'$
 (FIG. 2.54
 DESIGN OF SMALL DAMS)

$H = 7.9$

$\frac{0.3}{C}$ FROM FIG. 2.54 DESIGN OF SMALL DAMS

$$L = \frac{(94.5 + 94.5 + (7.9 \times 1.5))}{2}$$

$= 100.4'$

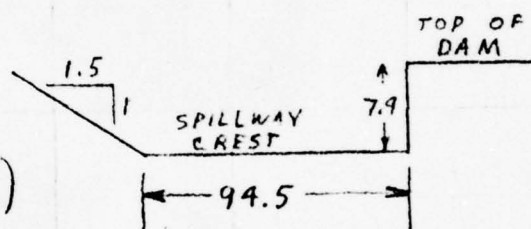
$Q = \frac{C}{8} C L H^{3/2}$

$= .58 \times 3.8 \times 100.4 \times (7.9)^{1.5}$

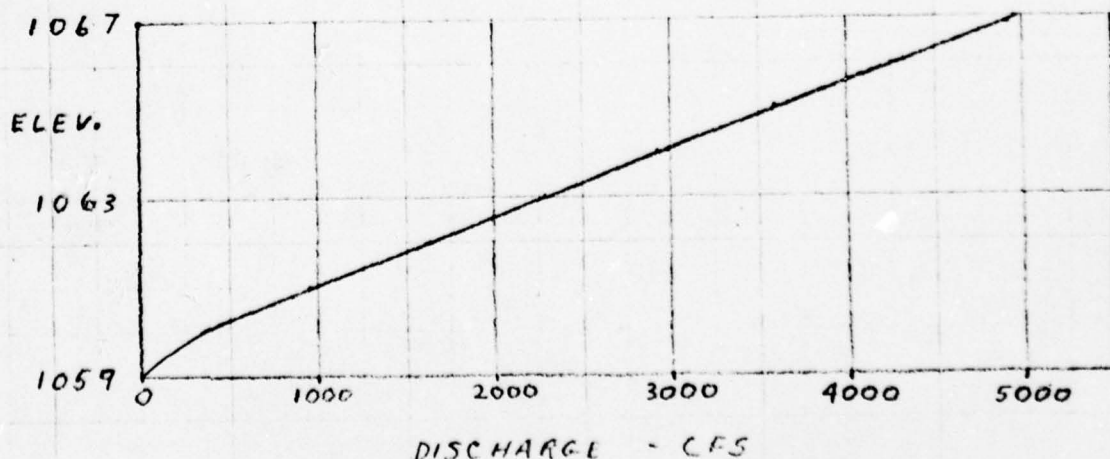
$= 4913 \text{ CFS} \quad \text{SAY } 4910 \text{ CFS}$

SPILLWAY CREST
 1059

OGEE
 SECTION



SPILLWAY RATING CURVE



BY RLS DATE 12/18/78
CHKD. BY WR DATE 12/27/78
SUBJECT _____

BERGER ASSOCIATES

SHEET NO. 5 OF
PROJECT D8490

GREENWOOD DAM

MAXIMUM KNOWN FLOOD AT DAMSITE

THE MAXIMUM KNOWN FLOOD AT GREENWOOD DAM OCCURRED IN 1972. AT THAT TIME THE WATER LEVEL IN THE POOL REACHED AN ELEVATION ABOUT 3.5' HIGHER THAN THE SPILLWAY CREST

$$C = 3.8$$
$$H = 3.5'$$

$$H_D = 0.6'$$
$$\frac{C_D}{C} \text{ FROM FIG. 254 DESIGN OF SMALL DAMS}$$

$$L = \frac{(94.5 + 94.5 + (3.5 \times 1.5))}{2}$$
$$= 97.1'$$

$$Q = \frac{C_D}{C} C L H^{3/2}$$

$$= .81 \times 3.8 \times 97.1 \times (3.5)^{1.5}$$

$$= 1957 \text{ CFS}$$

SAY 1960 CFS

BY RLS DATE 11/30/78
CHKD. BY DJR DATE 12/27/78
SUBJECT _____

BERGER ASSOCIATES

SHEET NO. 1 OF 1
PROJECT D8490

GREENWOOD DAM

DISCHARGE THROUGH OUTLET WORKS

2 - 20" PIPES

$$L = 145'$$

$$EL = 1030 \pm$$

$$A = 2.18$$

$$R = .417 \quad R^{2/3} = .55786$$

$$N = .015$$

$$\text{TAILWATER ELEV} = 1035$$

$$\text{FOR POOL LEVEL} = 1059$$

$$H = 1059 - 1035 = 24$$

$$S = .1655$$

$$Q = \frac{1.486}{N} A R^{2/3} S^{1/2}$$

$$= \frac{1.486}{.015} \times 2.18 \times .55786 \times (.1655)^{1/2} = 49 \text{ CFS}$$

$$\times 2 = 98 \text{ CFS}$$

SAY 100 CFS

$$\text{FOR POOL LEVEL} = 1039$$

$$H = 4$$

$$S = .0276$$

$$Q = \frac{1.486}{N} A R^{2/3} S^{1/2}$$

$$= \frac{1.486}{.015} \times 2.18 \times .55786 \times (.0276)^{1/2} = 20 \text{ CFS}$$

$$\times 2 = 40 \text{ CFS}$$

BY RLS DATE 1/10/79
CHKD. BY _____ DATE _____
SUBJECT _____

BERGER ASSOCIATES

SHEET NO. 7 OF
PROJECT D 8490

EMBANKMENT RATING

1066.3

$$2.7 \times 328 \times .1^{3/2} = 28$$

1066.4

$$2.7 \times 69 \times .05^{3/2} = 2$$

$$2.7 \times 328 \times .2^{3/2} = 79$$

$$2.7 \times 38 \times .05^{3/2} = 1$$

$$\Sigma = 82$$

1066.8

$$2.7 \times 42 \times .2^{3/2} = 10$$

$$2.7 \times 69 \times .45^{3/2} = 56$$

$$2.7 \times 328 \times .6^{3/2} = 412$$

$$2.7 \times 38 \times .45^{3/2} = 31$$

$$2.7 \times 132 \times .2^{3/2} = 32$$

$$2.7 \times 47 \times .05^{3/2} = 1$$

$$\Sigma = 542$$

1067.0

$$2.7 \times 16 \times .15^{3/2} = 3$$

$$2.7 \times 110 \times .1^{3/2} = 9$$

$$2.7 \times 11 \times .15^{3/2} = 2$$

$$2.7 \times 42 \times .4^{3/2} = 29$$

$$2.7 \times 69 \times .65^{3/2} = 98$$

$$2.7 \times 328 \times .8^{3/2} = 633$$

$$2.7 \times 38 \times .65^{3/2} = 54$$

$$2.7 \times 132 \times .4^{3/2} = 90$$

$$2.7 \times 47 \times .25^{3/2} = 16$$

$$2.7 \times 18 \times .1^{3/2} = 2$$

$$2.7 \times 10 \times .05^{3/2} = 0$$

$$\Sigma = 936$$

1067.4

$$2.7 \times 27 \times .55^{3/2} = 30$$

$$2.7 \times 128 \times .5^{3/2} = 122$$

$$2.7 \times 174 \times .8^{3/2} = 54$$

$$2.7 \times 107 \times 1.05^{3/2} = 311$$

$$2.7 \times 328 \times 1.2^{3/2} = 1164$$

$$2.7 \times 47 \times .65^{3/2} = 67$$

$$2.7 \times 10 \times .4^{3/2} = 8$$

BY RLS DATE 1/10/79
CHKD. BY _____ DATE _____
SUBJECT _____

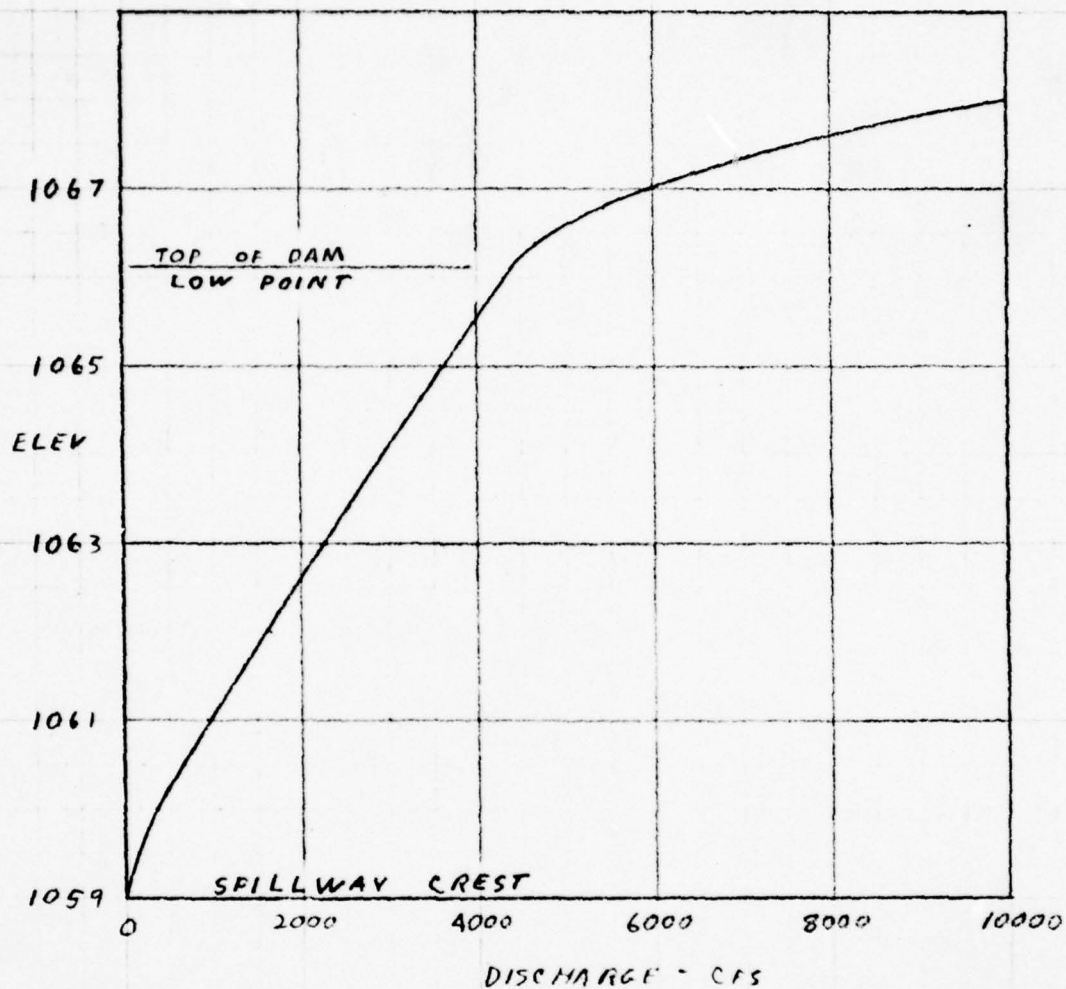
BERGER ASSOCIATES

SHEET NO. 8 OF _____
PROJECT D8490

GREENWOOD DAM

DISCHARGE RATING CURVE

INCLUDES SPILLWAY AND EMBANKMENT



BY RLS DATE 12/27/78
CHKD. BY _____ DATE _____
SUBJECT _____

BERGER ASSOCIATES

SHEET NO. 9 OF _____
PROJECT D8490

GREENWOOD DAM

SIZE CLASSIFICATION

MAXIMUM STORAGE = 2160 ACRE-Feet

MAXIMUM HEIGHT = 32 FEET

SIZE CLASSIFICATION IS INTERMEDIATE.

HAZARD CLASSIFICATION

THE LAKE HAUTO DAM LIES IMMEDIATELY
DOWN STREAM

USE "HIGH".

RECOMMENDED SPILLWAY DESIGN FLOOD

THE ABOVE CLASSIFICATIONS INDICATE USE
OF AN SDF EQUAL TO THE PROBABLE
MAXIMUM FLOOD.

BY RLS DATE 1/31/79
CHKD. BY _____ DATE _____
SUBJECT _____

BERGER ASSOCIATES

SHEET NO. 10 OF _____
PROJECT 08490

GREENWOOD DAM

HEC-1 DATA

DRAINAGE AREA = 5.58 SQ. MI.

DELAWARE BASIN REGION 2

CP = 0.45

LONGEST WATER COURSE = 20000' = 3.79 MI.

L TO CENTROID = 10500' = 1.99 MI.

$$T_p = 2.1 (L \times L_{CA})^{0.3}$$

$$T_p = 3.85$$

RAINFALL (HMR - 33)

INDEX = 22.6"

ZONE 6

INCREMENTAL RAINFALL

6 HR = 113%

12 HR = 123%

24 HR = 132%

48 HR = 142%

PLANIMETERED AREAS (FROM QUAD SHEETS)

ELEV : 1059 = 111.1 ACRES

1060 = 130.4 ACRES

1080 = 275.5 ACRES

ZERO STORAGE ELEV. = 1059 - H

H = STORAGE X 3 / AREA

$$= 1135 \times 3 / 111.1 = 30.6$$

ELEV = 1028.4

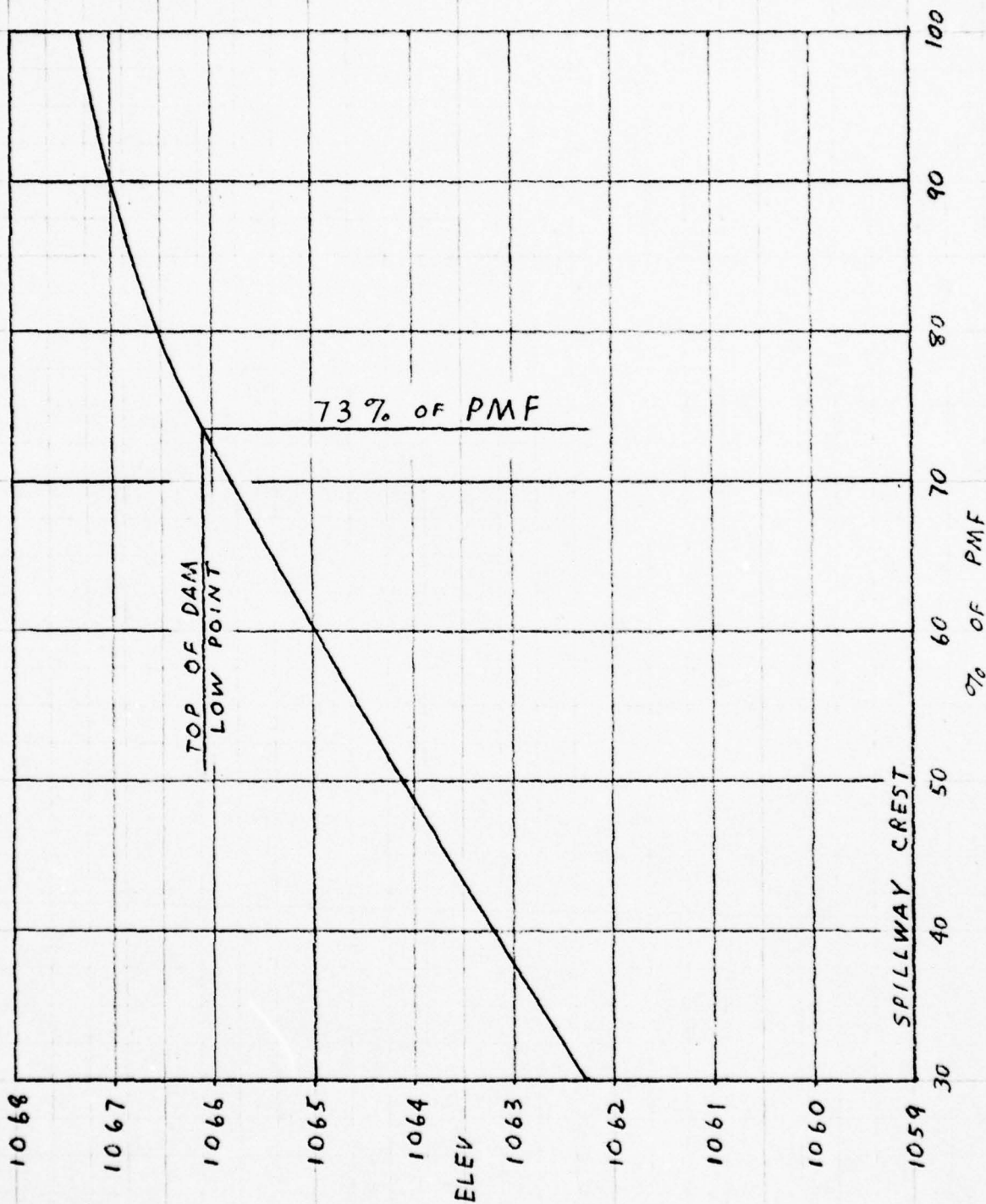
BY RLS DATE 1/11/79
CHKD. BY _____ DATE _____
SUBJECT _____

BERGER ASSOCIATES

SHEET NO. 11 OF _____
PROJECT D8490

GREENWOOD DAM

SPILLWAY CAPACITY CURVE



BY PLS DATE 2/13/79
CHKD. BY _____ DATE _____
SUBJECT _____

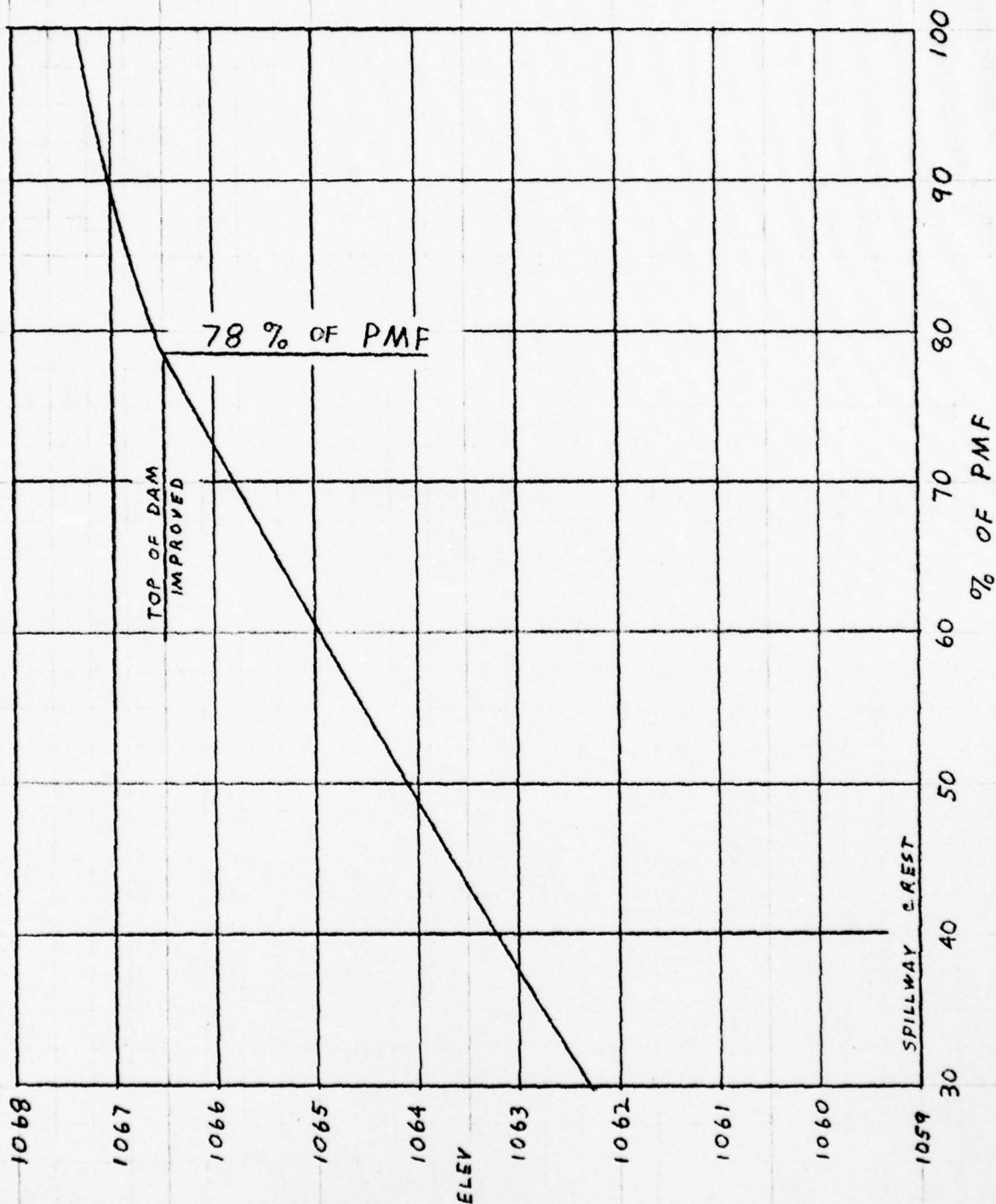
BERGER ASSOCIATES

SHEET NO. 12 OF _____
PROJECT D8490

GREENWOOD DAM

SPILLWAY CAPACITY CURVE

IMPROVED EMBANKMENT



DAM SAFETY VERSION JULY 1978
 LAST MODIFICATION 21 AUG 78

OVERTOPPING ANALYSIS

1/4

1	A1	GREENWOOD DAM	****	NESQUEHONING CREEK								
2	A2	RUSH TWP., SCHUYLKILL COUNTY, PA.										
3	A3	NDI # PA-00701		PA DER # 54-31-T1								
4	B	300	0	15	0	0	0	0	0	0	-4	0
5	B1	5										
6	J	1	9	1								
7	J1	1	.9	.8	.7	.6	.5	.4	.3	.15		
8	K		1						1			
9	K1											
10	M	1	1	5.58								1
11	P		22.6	113	123	132	142					
12	T							1	.05			
13	W	3.85	.45									
14	X	-1.5	-.05	2								
15	K	1	2					1				
16	K1											
17	Y				1	0						
18	Y1	1						1135	-1			
19	Y4	1059	1060	1061	1062	1063	1064	1065	1066.1	1066.4	1066.8	
20	Y4	1067	1067.4	1068								
21	Y5	0	355	960	1642	2282	2922	3594	4378	4674	5443	
22	Y5	5948	7080	9980								
23	\$A	0	111.1	130.4	275.5							
24	\$E	1028.4	1059	1060	1080							
25	\$I	1059										
26	\$D	1066.1										
27	K	99										

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT	1
ROUTE HYDROGRAPH TO	2
END OF NETWORK	

 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION JULY 1978
 LAST MODIFICATION 21 AUG 78

RUN DATE# 79/01/12.
 TIME# 05.43.47.

GREENWOOD DAM **** NESQUEHONING CREEK
 RUSH TWP., SCHUYLKILL COUNTY, PA.
 NDI # PA-00701 PA DER # 54-31-T1

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	15	0	0	0	0	0	-4	0
			JOPER	NWT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED

NPLAN= 1 NRTIO= 9 LRTIO= 1
 RTIOS= 1.00 00 00 70 10 50 10 70 10

MULTI-PLAN ANALYSES TO BE PERFORMED

NPLAN= 1 NRTIO= 9 LRTIO= 1
 RTIOS= 1.00 .90 .80 .70 .60 .50 .40 .30 .15

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

ISTAD ICOMP IECON ITAPE JPLT JPRT INAME ISTAGE IAUTO
 1 0 0 0 0 0 1 0 0

HYDROGRAPH DATA

IHYDG IUNG TAREA SNAP TRSDA TRSPC RATIO ISNOW ISAME LOCAL
 1 1 5.58 0.00 5.58 0.00 0.000 0 1 0

PRECIP DATA

SFFE PMS R6 R12 R24 R48 R72 R96
 0.00 22.60 113.00 123.00 132.00 142.00 0.00 0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT STRKR DLTAR RTIOL ERAIN STRKS RTIOK STRTL CNSTL ALSMX RTIMP
 0 0.00 0.00 1.00 0.00 0.00 1.00 1.00 .05 0.00 0.00

UNIT HYDROGRAPH DATA

TP= 3.85 CP= .45 NTA= 0

RECESSION DATA

STRTQ= -1.50 ORCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 100 END-OF-PERIOD ORDINATES, LAG= 3.88 HOURS, CP= .45 VOL= .98

6.	24.	49.	80.	115.	152.	193.	235.	278.	317.
351.	380.	403.	420.	430.	431.	421.	404.	388.	373.
358.	344.	330.	317.	304.	292.	280.	269.	258.	248.
238.	228.	219.	210.	202.	194.	186.	179.	172.	165.
158.	152.	146.	140.	134.	129.	124.	119.	114.	110.
105.	101.	97.	93.	89.	86.	82.	79.	76.	73.
70.	67.	64.	62.	59.	57.	55.	53.	50.	48.
46.	45.	43.	41.	39.	38.	36.	35.	34.	32.
31.	30.	28.	27.	26.	25.	24.	23.	22.	21.
21.	20.	19.	18.	17.	17.	16.	15.	15.	14.

0

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
-------	-------	--------	------	------	------	--------	-------	-------	--------	------	------	------	--------

SUM 25.67 23.28 2.40 329400.
 (652.)(591.)(61.)(9327.57)

HYDROGRAPH ROUTING

RESERVOIR ROUTING

ISTAQ ICOMP IECON ITAPE JPLT JPRT INAME ISTAGE IAUTO
 2 1 0 0 0 0 1 0 0

HYDROGRAPH ROUTING

RESERVOIR ROUTING										
	ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO	
	2	1	0	0	0	0	1	0	0	
ROUTING DATA										
	QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR		
	0.0	0.000	0.00	1	0	0	0	0		
	NSTPS	NSTD	LAG	AMSKK	X	TSK	STORA	ISPRAT		
	1	0	0	0.000	0.000	0.000	1135.	-1		
STAGE	1059.0	1060.0	1061.0	1062.0	1063.0	1064.0	1065.0	1066.1	1066.4	1066.6
	1067.0	1067.4	1068.0							
FLOW	0.	355.	960.	1642.	2282.	2922.	3594.	4378.	4674.	5443.
	5948.	7080.	9980.							
SURFACE AREA=	0.	111.	130.	276.						
CAPACITY=	0.	1133.	1254.	5223.						
ELEVATION=	1028.	1059.	1060.	1080.						
	CREL	SPWID	COGW	EXFW	ELEVL	COQL	CAREA	EXPL		
	1059.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
DAM DATA										
	TOPEL	COGD	EXPD	DAMWID						
	1066.1	0.0	0.0	0.						

PEAK OUTFLOW IS 6820. AT TIME 45.00 HOURS

PEAK OUTFLOW IS 5899. AT TIME 45.25 HOURS

PEAK OUTFLOW IS 4934. AT TIME 45.75 HOURS

PEAK OUTFLOW IS 4165. AT TIME 46.00 HOURS

PEAK OUTFLOW IS 3568. AT TIME 46.00 HOURS

PEAK OUTFLOW IS 2979. AT TIME 46.00 HOURS

PEAK OUTFLOW IS 2396. AT TIME 46.00 HOURS

PEAK OUTFLOW IS 1809. AT TIME 45.75 HOURS

PEAK OUTFLOW IS 879. AT TIME 46.00 HOURS

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS

FLOW IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS								
				RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	RATIO 7	RATIO 8	RATIO 9
				1.00	.90	.80	.70	.60	.50	.40	.30	.15
HYDROGRAPH AT	1	5.58	1	7581.	6823.	6065.	5307.	4549.	3791.	3033.	2274.	1137.
	(14.45)		(214.68)	(193.21)	(171.74)	(150.27)	(128.81)	(107.34)	(85.87)	(64.40)	(32.20)	
ROUTED TO	2	5.58	1	6820.	5899.	4934.	4165.	3568.	2979.	2396.	1809.	879.
	(14.45)		(193.13)	(167.04)	(139.73)	(117.94)	(101.03)	(84.37)	(67.86)	(51.21)	(24.89)	

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1		INITIAL VALUE		SPILLWAY CREST		TOP OF DAM	
ELEVATION		1059.01		1059.00		1066.10	
STORAGE		1135.		1133.		2164.	
OUTFLOW		5.		0.		4378.	
RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1067.31	1.21	2373.	6820.	6.25	45.00	0.00
.90	1066.98	.88	2316.	5899.	5.00	45.25	0.00
.80	1066.54	.44	2239.	4934.	3.25	45.75	0.00
.70	1065.80	0.00	2114.	4165.	0.00	46.00	0.00
.60	1064.96	0.00	1976.	3568.	0.00	46.00	0.00
.50	1064.09	0.00	1837.	2979.	0.00	46.00	0.00
.40	1063.18	0.00	1699.	2396.	0.00	46.00	0.00
.30	1062.26	0.00	1564.	1809.	0.00	45.75	0.00
.15	1060.87	0.00	1369.	879.	0.00	46.00	0.00

 FLOOD HYDROGRAPH PACKAGE (HEC-1)

DAM SAFETY VERSION JULY 1978

LAST MODIFICATION 21 AUG 78

EOT ENCOUNTERED.

>

FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 21 AUG 78

OVERTOPPING ANALYSIS
IMPROVED EMBANKMENT

1/4

1	A1	GREENWOOD DAM	****	NESQUEHONING CREEK							
2	A2	RUSH TWP., SCHUYLKILL COUNTY, PA.									
3	A3	NDI # PA-00701	PA DER #	54-31-T1							
4	B	300	0	15	0	0	0	0	0	-4	0
5	R1	5									
6	J	1	9	1							
7	J1	1	.9	.8	.7	.6	.5	.4	.3	.15	
8	K		1					1			
9	K1			INFLOW HYDROGRAPH							
10	M	1	1	5.58						1	
11	P		22.6	113	123	132	142				
12	T							1	.05		
13	W	3.85	.45								
14	X	-1.5	-.05	2							
15	K	1	2					1			
16	K1			RESERVOIR ROUTING							
17	Y			1	0						
18	Y1	1						1135	-1		
19	Y4	1059	1060	1061	1062	1063	1064	1065	1066.5	1067	1068
20	Y5	0	355	960	1642	2282	2922	3594	4689	4922	5461
21	YA	0	111.1	130.4	275.5						
22	YE	1029.4	1059	1060	1080						
23	YE	1059									
24	YE	1066.5	2.7	1.5	821						
25	K	99									

1

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT	1
ROUTE HYDROGRAPH TO	2
END OF NETWORK	

FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 21 AUG 78

RUN DATE* 79/02/13.
TIME* 06.20.08.

GREENWOOD DAM **** NESQUEHONING CREEK
RUSH TWP., SCHUYLKILL COUNTY, PA.
NDI # PA-00701 PA DER # 54-31-T1

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	15	0	0	0	0	0	-4	0
JOPER				NWT	LROPT	TRACE			
5				0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED

NPLAN= 1 NRTIO= 9 LRTIO= 1

RTIOS= 1.00 .90 .80 .70 .60 .50 .40 .30 .15

MULTI-PLAN ANALYSES TO BE PERFORMED

NPLAN= 1 NRTIO= 9 LRTIO= 1

RTIOS= 1.00 .90 .80 .70 .60 .50 .40 .30 .15

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

ISTAQ ICOMP IECON ITAPE JPLT JPRT INAME ISTAGE IAUTO
1 0 0 0 0 0 1 0 0

HYDROGRAPH DATA

IHYDG IUHG TAREA SNAP TRSDA TRSPC RATIO ISNOW ISAME LOCAL
1 1 5.58 0.00 5.58 0.00 0.000 0 1 0

PRECIP DATA

SPFE PMS R6 R12 R24 R48 R72 R96
0.00 22.60 113.00 123.00 132.00 142.00 0.00 0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT STRKR DLTKR RTIOL ERAIN STRKS RTIOK STRTL CNSTL ALSMX RTIMP
0 0.00 0.00 1.00 0.00 0.00 1.00 1.00 .05 0.00 0.00

UNIT HYDROGRAPH DATA

TP= 3.85 CP= .45 NTA= 0

RECESSION DATA

STRTO= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 100 END-OF-PERIOD ORDINATES, LAG= 3.88 HOURS, CP= .45 VOL= .98

6.	24.	49.	80.	115.	152.	193.	235.	278.	317.
351.	380.	403.	420.	430.	431.	421.	404.	388.	373.
358.	344.	330.	317.	304.	292.	280.	269.	258.	248.
238.	228.	219.	210.	202.	194.	186.	179.	172.	165.
158.	152.	146.	140.	134.	129.	124.	119.	114.	110.
105.	101.	97.	93.	89.	86.	82.	79.	76.	73.
70.	67.	64.	62.	59.	57.	55.	53.	50.	48.
46.	45.	43.	41.	39.	38.	36.	35.	34.	32.
31.	30.	28.	27.	26.	25.	24.	23.	22.	21.
21.	20.	19.	18.	17.	17.	16.	15.	15.	14.

END-OF-PERIOD FLOW

MO.DA HR.MN PERIOD RAIN EXCS LOSS COMP Q MO.DA HR.MN PERIOD RAIN EXCS LOSS COMP Q

SUM 25.67 23.28 2.40 329400.
(652.)(591.)(61.)(9327.57)

HYDROGRAPH ROUTING

RESERVOIR ROUTING

ISTAQ ICOMP IECON ITAPE JPLT JPRT INAME ISTAGE IAUTO
0 1 0 0 0 0 0 0 0

HYDROGRAPH ROUTING

RESERVOIR ROUTING

ISTAQ	ICOMP	IECON	ITAFE	JFLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTD	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	1135.	-1

STAGE	1059.0	1060.0	1061.0	1062.0	1063.0	1064.0	1065.0	1066.5	1067.0	1068.0
FLOW	0.	355.	960.	1642.	2282.	2922.	3594.	4689.	4922.	5461.

SURFACE AREA= 0. 111. 130. 276.

CAPACITY= 0. 1133. 1254. 5223.

ELEVATION= 1028. 1059. 1060. 1080.

CREL	SPWID	COOW	EXPW	ELEVL	COQL	CAREA	EXPL
1059.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
1066.5	2.7	1.5	821.

PEAK OUTFLOW IS 6858. AT TIME 45.00 HOURS

PEAK OUTFLOW IS 5888. AT TIME 45.25 HOURS

PEAK OUTFLOW IS 4797. AT TIME 46.00 HOURS

PEAK OUTFLOW IS 4174. AT TIME 46.00 HOURS

PEAK OUTFLOW IS 3568. AT TIME 46.00 HOURS

PEAK OUTFLOW IS 2979. AT TIME 46.00 HOURS

PEAK OUTFLOW IS 2396. AT TIME 46.00 HOURS

PEAK OUTFLOW IS 1809. AT TIME 45.75 HOURS

PEAK OUTFLOW IS 879. AT TIME 46.00 HOURS

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
 FLOWS IN CURIC FEET PER SECOND (CURIC METERS PER SECOND)
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS								
				RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	RATIO 7	RATIO 8	RATIO 9
				1.00	.90	.80	.70	.60	.50	.40	.30	.15
HYDROGRAPH AT	1	5.58	1	7581.	6823.	6065.	5307.	4549.	3791.	3033.	2274.	1137.
	(14.45)		(214.68)	(193.21)	(171.74)	(150.27)	(128.81)	(107.34)	(85.87)	(64.40)	(32.20)
ROUTED TO	2	5.58	1	6858.	5888.	4797.	4174.	3568.	2979.	2396.	1809.	879.
	(14.45)		(194.19)	(166.73)	(135.85)	(118.18)	(101.03)	(84.37)	(67.86)	(51.21)	(24.89)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1		INITIAL VALUE		SPILLWAY CREST		TOP OF DAM	
ELEVATION		1059.01		1059.00		1066.50	
STORAGE		1135.		1133.		2233.	
OUTFLOW		5.		0.		4689.	
RATIO OF PMF	MAXIMUM RESEVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1067.35	.85	2391.	6858.	5.25	45.00	0.00
.90	1067.05	.55	2329.	5888.	4.00	45.25	0.00
.80	1066.59	.09	2249.	4797.	1.50	46.00	0.00
.70	1065.79	0.00	2113.	4174.	0.00	46.00	0.00
.60	1064.96	0.00	1976.	3568.	0.00	46.00	0.00
.50	1064.09	0.00	1837.	2979.	0.00	46.00	0.00
.40	1063.18	0.00	1699.	2396.	0.00	46.00	0.00
.30	1062.26	0.00	1564.	1809.	0.00	45.75	0.00
.15	1060.87	0.00	1369.	879.	0.00	46.00	0.00

 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION JULY 1978
 LAST MODIFICATION 21 AUG 78

EOI ENCOUNTERED.

N>

TERMINAL 255 TIME OUT.

BYE 79/02/13, 06.42.23.

zZ

APPENDIX D
GEOLOGIC REPORT

APPENDIX D

GEOLOGIC REPORT

Bedrock - Dam and Reservoir

Formation Name: Middle Member of the Mauch Chunk Formation.

Lithology: Grayish red and reddish brown sandstone interbedded with similarly colored siltstone, mudstone and shale. Some thin interbeds of green to grayish green mudstones are common.

Structure

The dam is located on the south limb of the Frackville anticline. Bedding plane thrust faults are mapped on both the north and south sides of the valley of Nesquehoning Creek. The beds in the vicinity of the dam strike N70° to N80°E.

Fracture traces trend N5° to 15°E.

Overburden

No core borings or other foundation information is available for this dam, which was built in 1880. The overburden is probably similar to that at Lake Hauto, immediately downstream. There the overburden consisted of boulders, sand and clay. Better sorted and more permeable alluvium was probably present also.

Aquifer Characteristics

The colluvium on which this dam is apparently founded is generally fairly impermeable material, especially where the clay content is high. More permeable zones do occur in some places. Where alluvium is present it can also be quite permeable.

Discussion

An inspection report dated April, 1915 states it is the "writers impression that no core or cutoff walls were constructed". This apparently means that this dam was founded directly on the colluvium and alluvium in the valley. The spillway constructed in 1935 is in bedrock however. After the dam was completed considerable leakage was noted near the outlet pipes. It was the inspector's opinion

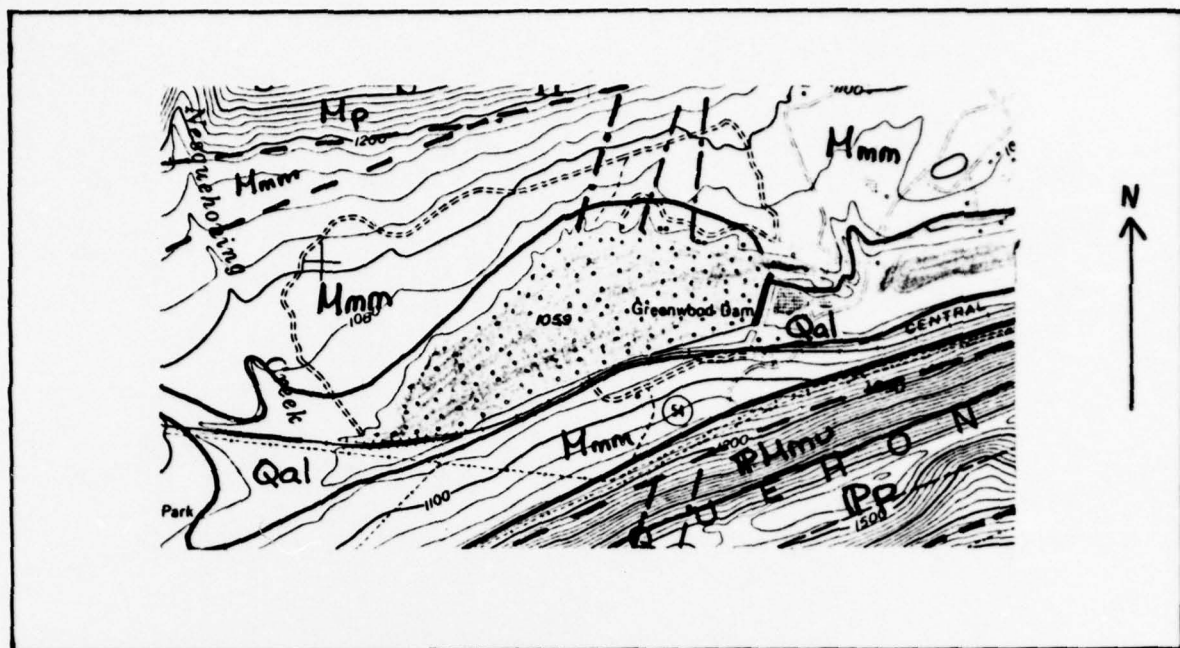
Discussion (Cont'd)

that the leakage was under the dam rather than through the embankment. This is certainly likely, in view of the foundation material. Leakage was measured by means of weirs for several years. After Lake Hauto was raised it was no longer possible to observe the leakage as water covered the outlet pipes of the Greenwood Dam. Leakage may be continuing. Air Photos taken in January 1969 show Greenwood Lake entirely covered by ice. There is open water just below the dam, however.

Sources of Information

1. Wood, Gordon H. (1974) "Geologic Map of the Tamaque Quadrangle, Carbon and Schuylkill Counties, Pa."
2. Air Photographs, scale 1:24,000, dated 1969.

GEOLOGIC MAP - Greenwood Dam



(geology from U.S.G.S. Map GQ-1133)

Qal

Alluvium

Pp

Pottsville Fm.

PMmu

Mauch Chunk Fm.; upper member

Mmm

Mauch Chunk Fm.; middle member

Mp

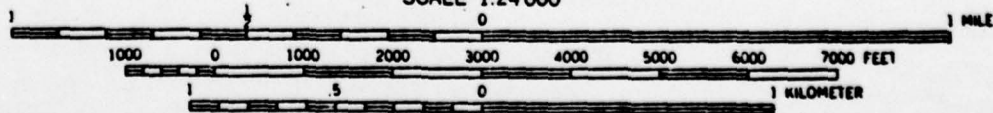
Pocono Fm.

thrust fault

....

air photo fracture trace

SCALE 1:24 000



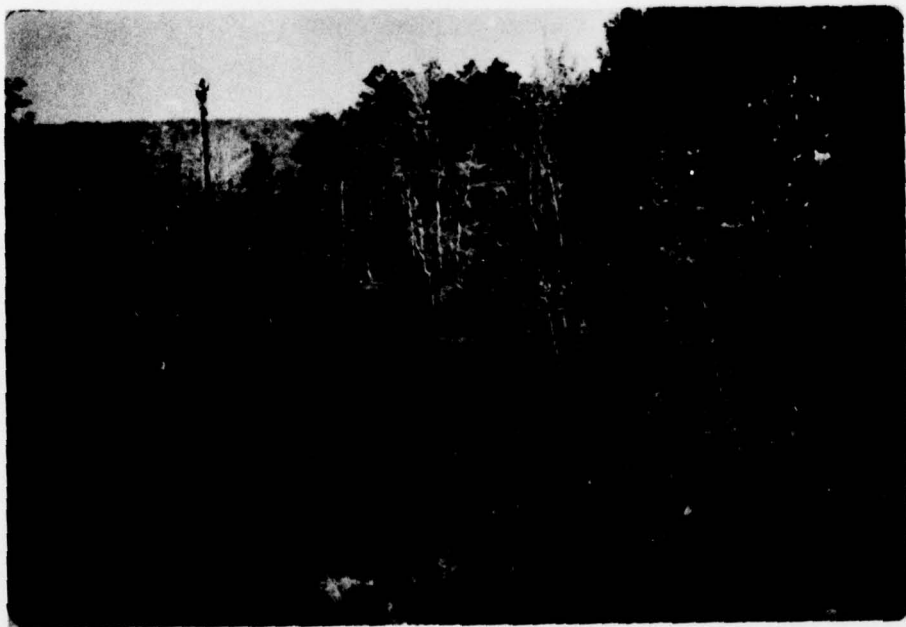
CONTOUR INTERVAL 20 FEET
 DOTTED LINE CENT 10-FOOT CONTOURS
 SEA LEVEL

APPENDIX E
PHOTOGRAPHS

APPENDIX E



Breast of Dam &
Upstream Concrete
Wall



Downstream
Embankment Slope

PA-701
PLATE E-I



Spillway Weir &
Discharge Channel



Downstream
Channel



Reservoir

PA-701
PLATE E-II



Operator's Platform
and Valves



Downstream Reservoir (Lake Hauto)
Looking Downstream from
Operator's Platform

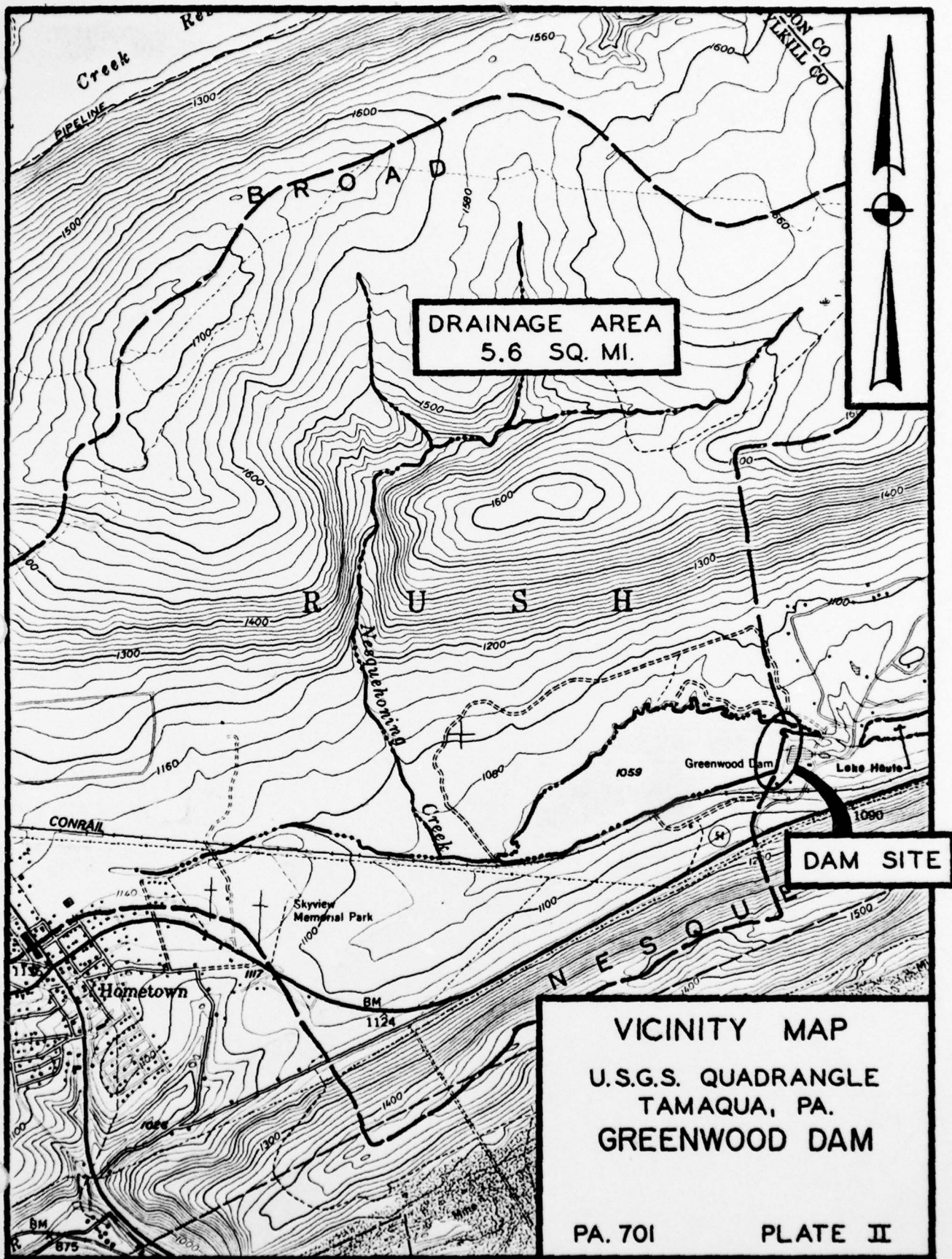
PA-701
PLATE E-III

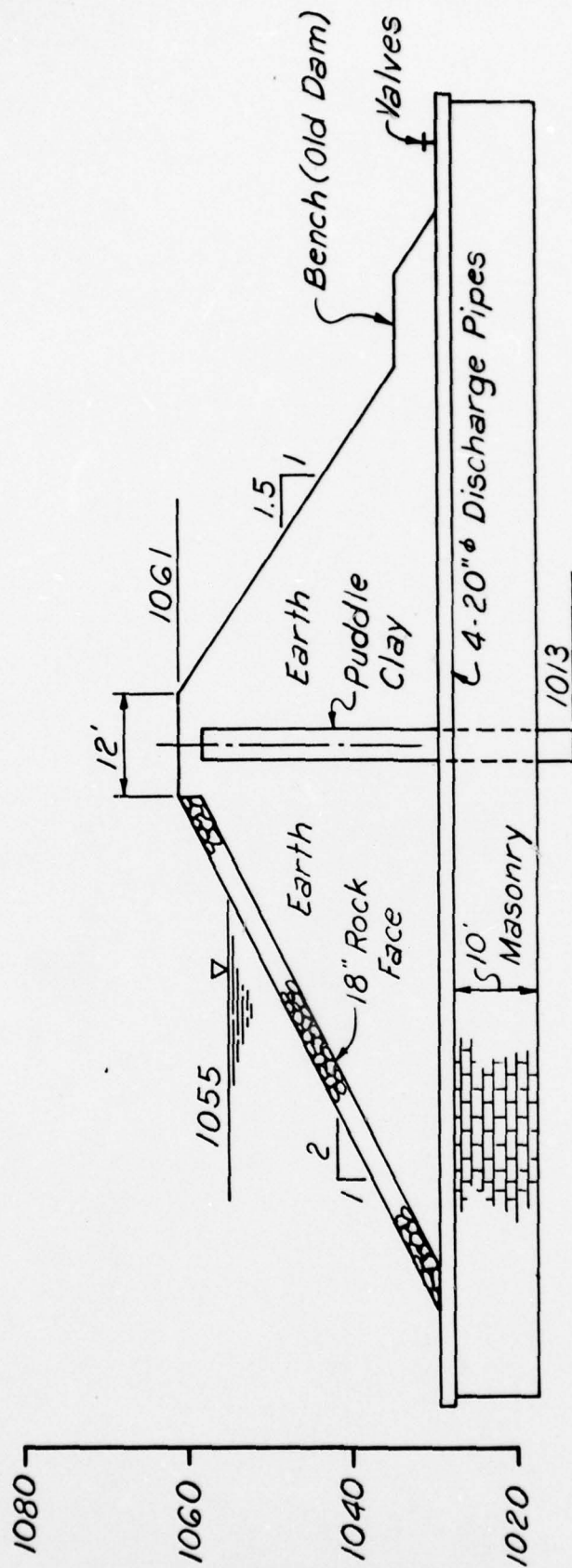
APPENDIX F

PLATES

APPENDIX F





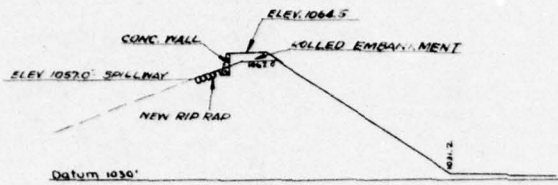


EMBANKMENT SECTION
AS CONSTRUCTED IN 1901 OR 1904

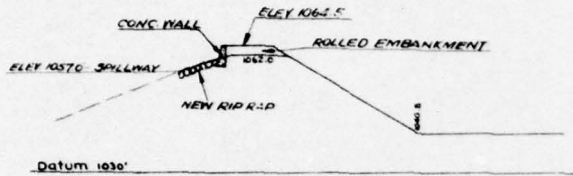
GREENWOOD DAM
PA. 701

PLATE III

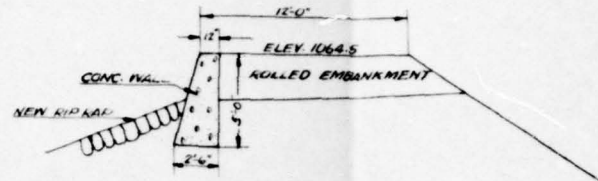
Sketched 12/12/78
from Owners Drawing



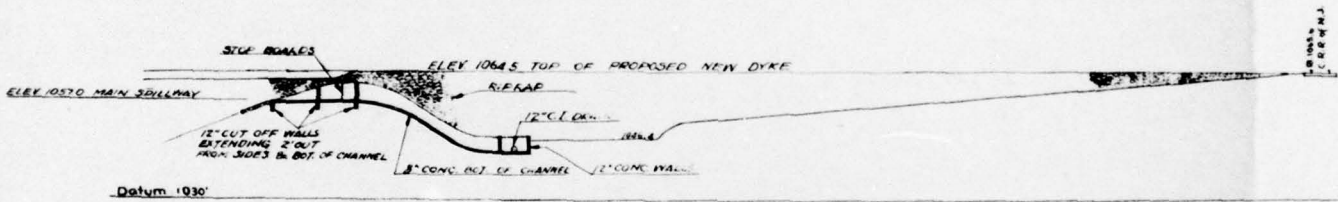
SECTION A
LOOKING NORTH
1"=20'



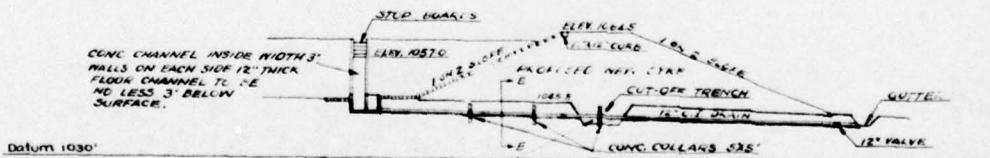
SECTION B
LOOKING NORTH
1"=20'



DETAIL
TOP OF MAIN DAM
SCALE 1/2"=1'
LOOKING NORTH



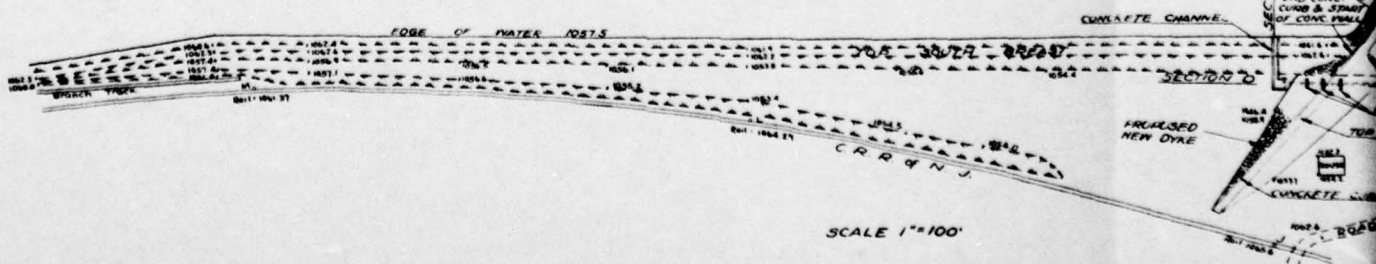
SECTION C
LOOKING EAST
1"=20'

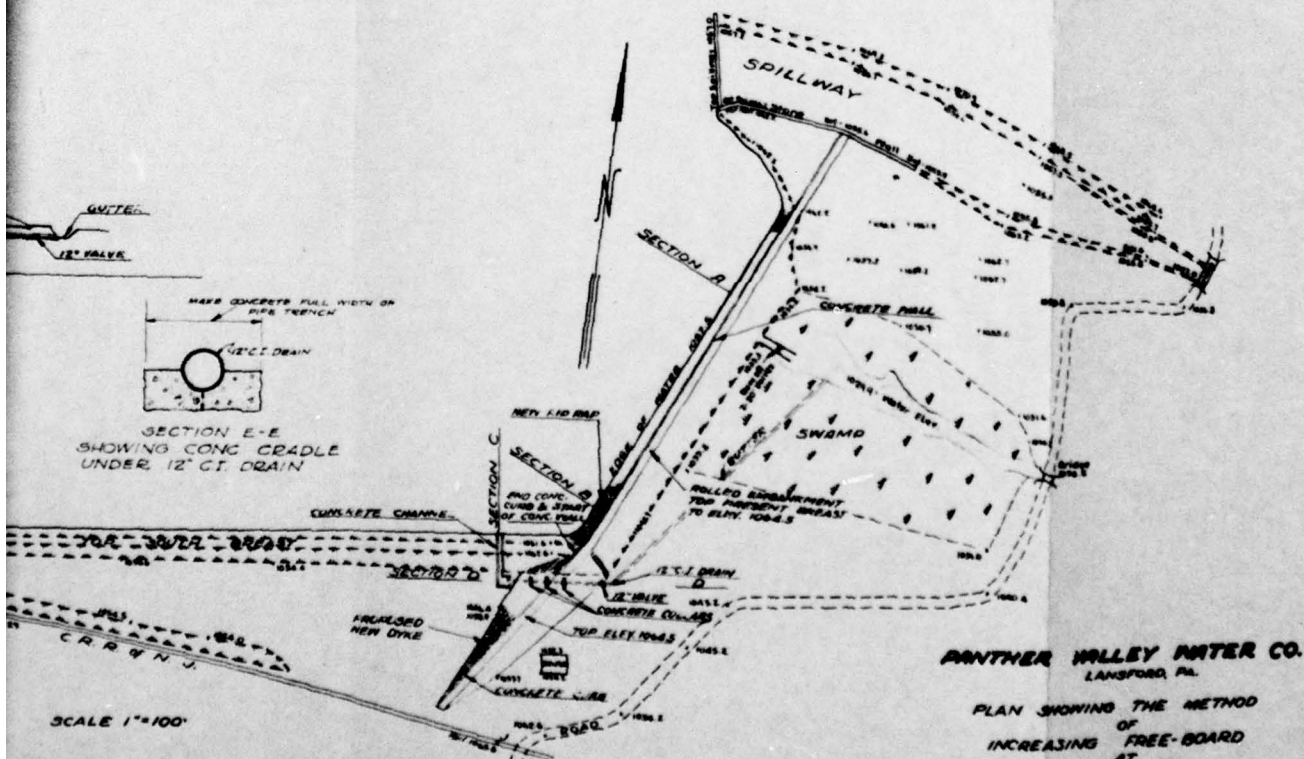
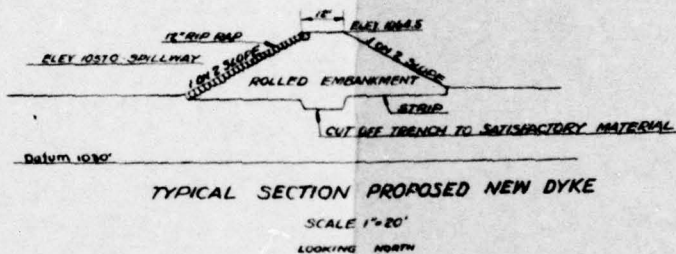
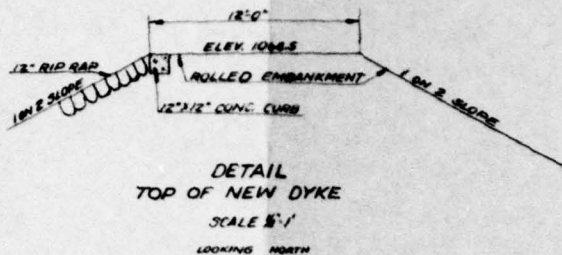
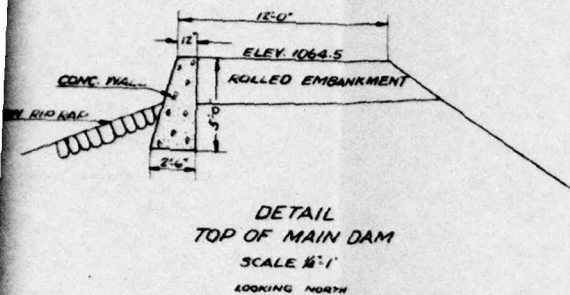


SECTION D
LOOKING NORTH
1"=20'



SECTION E-E
SHOWING CONC. CRADLE
UNDER 12" C.T. DRAIN



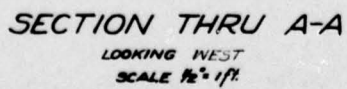
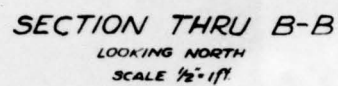


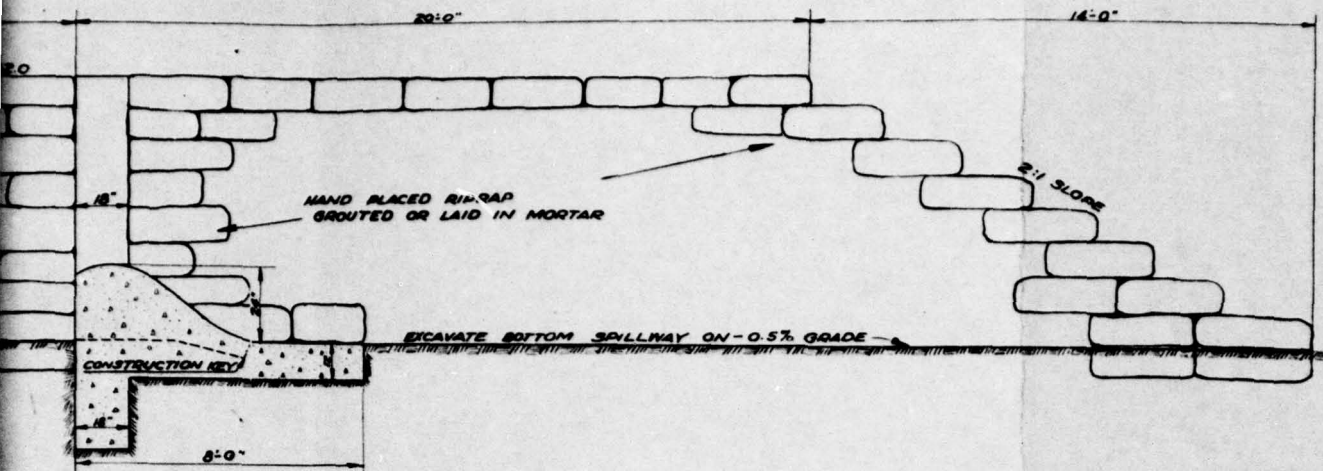
PANTHER VALLEY WATER CO.
LANSDOWN, PA.

PLAN SHOWING THE METHOD
OF
INCREASING FREE-BOARD
AT
GREENWOOD DAM

GANNETT, EASTMAN & FLEMING INC.
NEW YORK, N. Y. HARRISBURG, PA.
JUNE 1935

PA. 70
PLAT

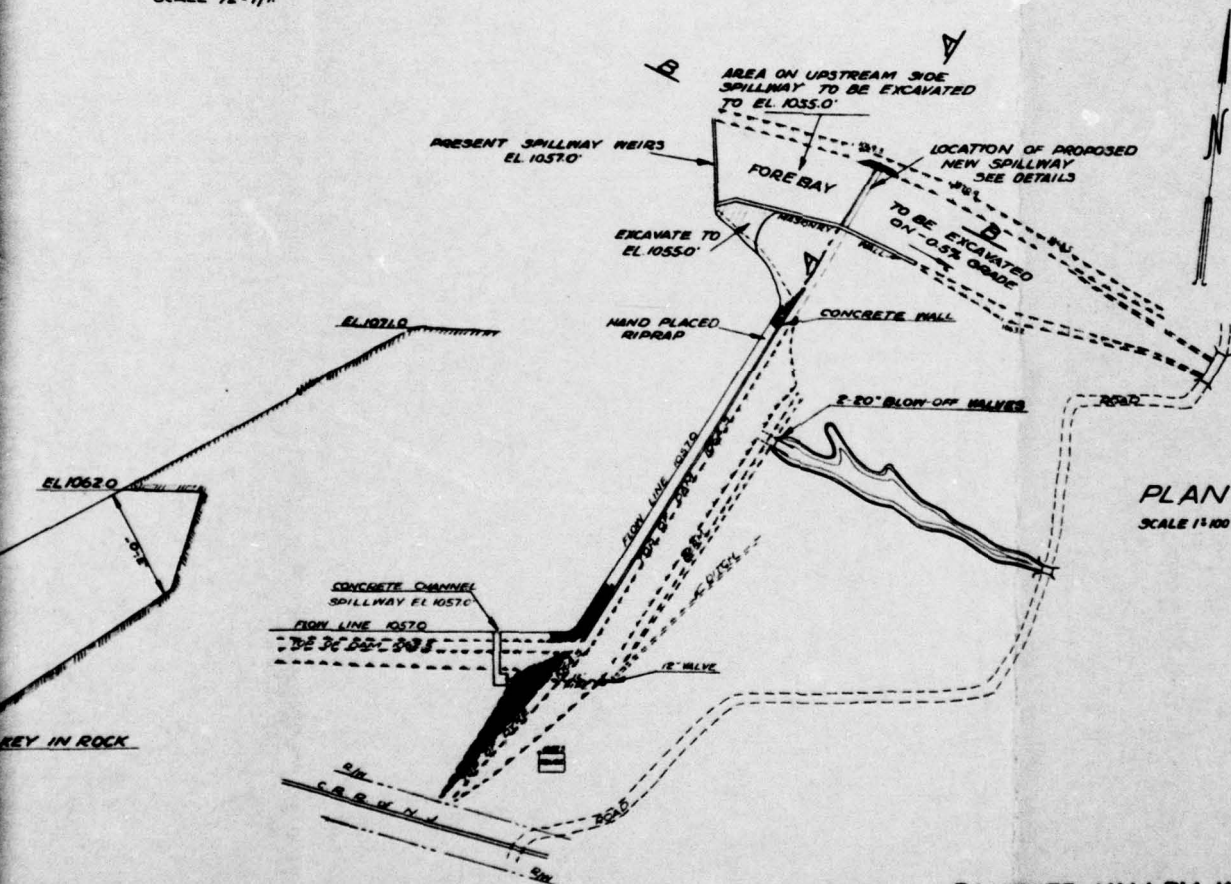




SECTION THRU B-B

LOOKING NORTH

SCALE 1/2"=1 FT.



PANTHER VALLEY WATER CO
LANSFORD, PA

DETAIL
OF
PROPOSED SPILLWAY
AT
GREENWOOD RESERVOIR

GANNETT EASTMAN AND FLEMING INC.
ENGINEERS
NEW YORK, N.Y. HARRISBURG, PA.
SEPT-1935
SCALE AS SHOWN